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THE POTTERY OF THE MOUND BUILDERS.

BY F. W. PUTNAM.

By the courtesy of the Trustees of the Peabody Museum of American Archæology and Ethnology, Cambridge, we are able to give the following account of the very interesting collection of articles, principally of pottery, from mounds in Missouri, forming the Swallow Collection which was secured by the Museum last year, and now recorded in the Eighth Annual Report of the Trustees made to the President and Fellows of Harvard College.

On the decease of Professor Wyman, the late Curator of the Museum, in September last, the Museum was then placed in charge of Professor Gray, as temporary Curator, who requested Mr. Putnam to write a report on the accessions to the Museum during the year, and the following extract is from the report addressed by him to Professor Gray.

To enable a ready comparison to be made with the several vessels referred to in the text as having been described in Col. Foster's "Prehistoric races of the United States," the woodcuts illustrating Col. Foster's article in a former number of the NATURALIST are reproduced at the end of this article.

The collection made by Prof. G. C. Swallow, recently secured by the Museum, is an important addition, particularly in articles of pottery and stone of the moundbuilders, and as a number of woodcuts representing many of the most interesting of the articles were received with the collection, they are here inserted

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together with the following abstract from the manuscript by Professor Swallow.

"We opened these mounds in December, 1856, and the following month. There were present, assisting with their servants and teams, Messrs. S. R. Phillips, John Martin, M.D., Clayton Lee, John Jackson, M. Jackson, Elijah Horrel, Dr. Case, Daniel Fulton, A. E. Sheelds of New Madrid, Missouri, and Geo. Northcutt of Columbia and some others.

"We cut a passage six feet wide entirely through the "Big Mound" from side to side and from top to bottom, laying open its entire structure.

"This mound is in Lewis' Prairie, west of New Madrid. It is elliptical in form, 900 feet in periphery at the base, 570 feet at the top which is nearly level and about 20 feet above the surrounding country. This is the wide bottom of New Madrid county some 60 miles long and 30 to 40 wide, and is known as the swamp country. This was the country effected by the New Madrid earthquake of 1811.

"A room seems to have been built by putting up poles (like rafters in the roof of a house); on these rafters were placed split cane (*Arundinaria macrosperma*); plaster, made of the marls of the bluff formation, was then applied above and below so as to form a solid mass, inclosing the rafters and lathing of cane, and this held all in place; over this room was built the earth work of the mound, so that when it was completed the room was in its centre. The earth work was then coated with the plaster, and over all nature formed a soil.

"This mud plastering was left rough on the outside of the room, but smooth on the inside which was painted with red ochre. (One of the pots found had been used as a paint pot).

"Some of the plastering was burned hard as brick, but other parts were only sun dried, as shown by the pieces sent.

"Some of the rafters and cane lathes were found decayed, some burned to coal and others all rotted but the bark. Some of the rafters were, probably, of cypress, and others, of elm. This inner plastering was found flat on the floor of the room as it had fallen in, and under it were the bones and pots, the latter including one that contained a human skull, which we found at one side. This vessel was first hit by the point of the plow. It was bottom up, and not broken nor even cracked when I took it out of its

resting place, the skull within was not broken and could not be taken out without breaking it or the pot, a fact which attracted much comment at the time. I remember one remark of Mr. Phillips.—"The pot was made over the person's head as a punishment." The pot[1] and skull were afterwards broken by an accident to the box in which it was packed.

"All the articles in this mound were well preserved as the plastering protected them from the elements."

The character of the articles found in the "Big Mound" mentioned in the foregoing account by Prof. Swallow, will be understood from the following short descriptions and accompanying illustrations. The woodcuts, though rather roughly executed, are generally quite characteristic of the articles represented. The numbers used in the descriptions and to designate the figures are those under which the articles are entered in the Museum Catalogue.

The clay in some of the vessels has been mixed with more or less finely pounded shells, probably of fresh water muscles. In other instances the pounded shell has not been used, but fragments of charcoal are to be traced, indicating that either charcoal itself was used to temper the clay, or else, which is more likely, that some vegetable substance was mixed with the clay, which, in burning the vessels, was reduced to charcoal. In a few of the specimens sand was mixed with the clay, and in several, the clay was apparently without any mixture. These last are generally thick and rude in their finish, while those in which charcoal is now seen are generally the thinnest and among the more finely finished vessels, as in No. 7800.

Many of the vessels from these Missouri mounds show evidence of having been heated both on the inside and outside; but several appear not to have been so heated, and these are not so finely and smoothly finished as those which have been hardened by fire.

The best finished of these vessels have the appearance, noticed by Squier and Davis in other specimens from the mounds, of having been carefully shaved by a sharp knife on the outside. The same appearance is observable in the dark, Peruvian pottery. It is possible that this was produced by making the clay on the outside of

[1] This vessel is represented as Fig. 7761; a small portion of it is missing from near the bottom, and a few fragments of a human cranium and the vertebra of a *deer* are now in it. Prof. Swallow has made mention of this skull in the Proceedings of the Amer. Assoc. Adv. Sci., xxii, B, 401.—F. W. P.

the vessels very wet and then hastily smoothing it just before it was baked. The unburnt specimens do not have this peculiar, smooth surface.

No. 7776. A jar surmounted by the figure of a woman sitting upon her feet, represented by the two lower protuberances, as seen in the figure giving the back view. The upper of the three pro-

No. 7776.

jections shown in the figure represents the curve of the back, and the front view shows the hands resting on the knees. This jar is 7·7 inches high, and 5·8 inches in greatest diameter. The bulging part has a nearly even diameter varying but ·2 of an inch. The jar is slightly flattened at its base so as to stand without tipping. The opening at the back of the head is one inch in transverse diameter by ·8 vertical.

No. 7775. This very odd vase or jar is made in the form of a woman represented in the same squatting position as that surmounting jar No. 7776. The jar is perfect, though, from the clay being less finely tempered than in the preceding, the features are not so strongly defined. Each ear is perforated by a small hole, and the pointed portion on top of the head probably indicates a different style of head dress from that of 7776. The back is represented as very much protruded, the breasts are large and well

formed. The dimensions of the vase are as follows: total height 4·6 inches; from knee to end of foot 2·5; from breasts to point of back 2·5; from shoulder to shoulder 2·4; diameter of opening in the back of the head from ·6 to ·7 of an inch. The very great

No. 7775.

resemblance of this figure to a small Mexican idol in the Museum (No. 1469) is very striking. The idol is carved in stone and represents a woman in this same squatting posture with her hands upon her knees. See also the figure of a man in this same posture in Foster's Prehistoric Races of the United States, p. 240. This last represents a water jar of the same general character as 7775 and is also from a mound in Missouri.

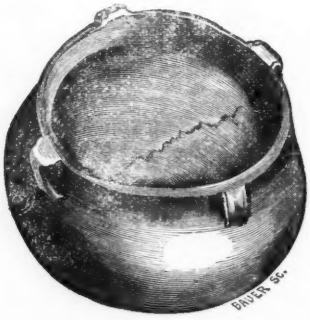
No. 7841. A large pipe carved from a hard sandstone and rudely representing a frog or a toad. The design is better seen from a side view than from the front as represented by the woodcut. The block of stone composing this pipe bowl weighs 3 pounds and 9 ounces, and is 5·5 inches in length, 3·7 in width and 3·9 in height. The head of the toad, or the part projecting from the front of the block, is 1·5 inches, the width of its mouth is 1·7, and the distance from the outside of one eye to the other is 1·2 inches. The diameters of the bowl of the pipe and of the hole for the stem are each 1·3 inches, and the two holes are equal in depth, 2 inches. The holes rapidly narrow as they extend inwards, being but ·2 of an inch in diameter at their union. The hole for the stem is symmetrical throughout, but

No. 7841.

that of the bowl is slanting on its front and nearly vertical on its posterior portion.

No. 7761. This is the vessel which Prof. Swallow states was found "near the side of the mound, bottom up and containing a human skull and one vertebra." It is rather rudely made and is

No. 7761.



not so smooth on its surface as the figure represents. There is very little mixture of other substances with the clay of which it is composed. A small portion broken out near the bottom shows it to be about ·4 of an inch thick, and also that the pot has been hardened by fire, both on the inside and the outside. As shown in the cut, it is provided with four handles symmetrically placed. It is 5 inches high, 6·3 to 6·5 in its greatest diameter and 4·6 to 4·8 inches across the mouth.

No. 7773

Nos. 7773 and 7764 are two pots very similar to the one last described. The largest of these, No. 7773, is 6 inches high, and

from 7·7 to 8 inches in diameter. The opening is 5·8 to 6·3 in diameter. The other is much thicker, and is about 5 inches high, by 6·8 in diameter.

Nos. 7820 and 7824, represented in the cuts of about one-

No. 7820.

No. 7824.

quarter their natural size, are probably handles broken from vases similar to those taken from another mound and here figured as No. 7717.

No. 7842 is probably a natural flint concretion that has been slightly worked over to form a small dish. Its shape is best seen by tipping the engraving over to the right. Its length is 4·4, width 3, and height 1·5 inches.

No. 7842.

No. 7843 is a small discoidal stone of diorite, quite smooth and polished. It is slightly concave on its upper surface, with flat bottom and vertical sides, and is 1·2 inches in diameter by ·5 of an inch in thickness.

No. 7843.

No. 7838. A double concave disk of sienite, 2·8 inches in diameter by 1·1 in thickness. The concavities are not over ·2 of an inch in their greatest depth. The sides of the stone are rounded. No. 7839 is another of these stones of the same shape, except that the sides are a little more rounded. This stone is slightly polished, perhaps by use. It is of the same thickness as the first mentioned but is ·6 of an inch less in diameter. With these is another discoidal stone, No. 7840, having a thickness through its centre of 1·4 and a diameter of 2·9 inches, but double convex in shape and made of a gray sandstone.

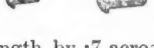
No. 7838.

These discoidal stones of various forms and sizes are very interesting relics, and as we know that such stones were used in games by the American Indians, especially by the Southern tribes and by the Mandans as described by Adair, Finly, Bartram, Catlin, and others, it is very probable that these stones wherever

found were used for similar purposes. Messrs. Squier and Davis, in "Ancient Monuments of the Miss. Valley," figure a number found in mounds and on the surface, and call attention to their enigmatical character and to the fact that they have been found from Ohio to Peru, and also in Denmark. So far as their observations go, they regard those found in the mounds as, probably, of more recent origin than the mounds, but those found by Prof. Swallow in the "Big mound" are evidently of the same age as the other articles in the collection, and the very large number from the Mounds in Tennessee, collected by Mr. Dunning and now in the museum, would indicate that they belong to the mound period as well as to later times. It is interesting in this connection to record two of these stones found in Hartford, Connecticut, by the Rev. E. C. Bolles, and now in the Peabody Academy of Science at Salem, and also to refer to the specimens in the Museum from the Hawaiian Islands, one of which, No. 2903, is labelled "Stone used in the *game of maika*, Hawaiian Islands." The game played with such stones by the Mandans is called "Tchung-kee," which Adair gives as "Chungke." From these names and the term "Chunky-yard," used by Bartram in his description of the peculiar enclosure in the Creek villages in which the game was played, these stones are now generally called "Chunky-stones," but it is questionable if this name should be given to any except those of large size which are perforated, as the game described by Catlin requires a "ring of stone" so that if the pole is well thrown the ring will fall upon one of the projecting points on the pole. That those not perforated may also have been used for some other game is probable from the fact that the stones used by the Hawaiians in their game of "maika" are, to judge from the several specimens in the museum, simple biconcave and biconvex disks, in every respect like those found in America. It is also very probable that some of the smaller stones of this character were used as paint rubbers, for it is evident that some such articles were required if paint were used.

Nos. 7873 and 7874 are two articles carved from a hard clay slate and carefully smoothed. Their use is problematical, but they so closely resemble lip ornaments as to suggest that they were such. The largest measures 1·2 inches in length by ·7 across the top; the other is ·9 of an inch in length by ·6 in greatest diameter.

No. 7874. No. 7873.

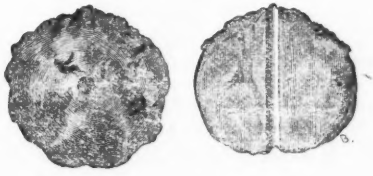


No. 7875 is a needle made of the point of a deer's antler. The larger end has been perforated by a small hole and is broken at this point. The woodcut does not give a very good idea of the specimen which is 3·3 inches long and ·5 of an inch in diameter at its large end. A similar needle, made of a deer's horn, was found by Stevens with a skeleton in an ancient burial place in Yucatan, and he states that the Indians of that country still use the same kind of needles. There is also an awl, 4·5 inches in length, which probably came from the Big mound, though it is not specially mentioned by Prof. Swallow. This awl is like those figured by Squier and Davis from mounds in Ohio, and is made from a bone of a deer.

No. 7875.

Nos. 7858, 7864 and 7865 are several masses of clay used as plaster on the chamber of the mound as described by Prof. Swallow, and several of the pieces show the impressions of the reeds over which the clay was spread. No. 7866 is a rough ball of burnt

No. 7866.



clay about 3·5 inches in diameter, and shows the impression of the skin and finger marks of the hands that moulded it. This mass was perforated through the centre as shown in the figure giving a section.

No. 7855 is a large hoe, beautifully chipped from a piece of brown flint. It is 11·3 inches in length, 5·1 in greatest width, and 1·1 in thickness through the centre. One of the surfaces is nearly flat and is much polished by wear on its lower third, while the opposite surface is slightly convex and only polished by wear along its lower edges.

No. 7834 is a polished celt of greenstone, worked in the form of a broad chisel. Its flat surface represented in the figure is 2·4 inches in greatest width and 4·7 from the rounded upper end to

the beginning of the bevelled edge, which is ·9 of an inch deep. The cutting edge is made by the grinding down of this side only.

No. 7852.

No. 7855.

No. 7854.

The opposite surface is flat along its central portion but the sides are rounded. The thickness of the stone is one inch.

No. 7852. This is a beautiful, little chisel of orange flint, polished on its two broad surfaces but with its sides left roughly chipped. The greatest width of the implement is across its cutting edge, which is made by grinding from both surfaces. Length 3·5, thickness ·7, width 1·4 inches.

Nos. 7853 and 7854 are two chipped flint chisels, long and nar-

No. 7853.

No. 7854.

row, and polished only at the cutting portion. The cutting edge is made by grinding from both surfaces. The cuts do not accurately represent these implements, which are chipped nearly flat on one surface and roughly convex on the opposite. They are of the same general shape, though of considerable difference in size.

The largest, which is made of a gray flint, is 7·6 inches in length, 1·5 in width across the centre and ·7 along the edge. The other is of a much lighter colored flint, and is 5 inches in length, ·7 of an inch in thickness, 1·1 in width, and has a cutting edge of ·6 of an inch.

There are also a number of other stone implements in the collection, some of which probably came from the mounds, and others were found on the surface. They are all from Missouri, and are as follows. Three thin triangular implements, No. 7844, about 4 inches in length, 3 in width and from ·4 to ·5 in thickness. These three implements would be classed either as small hatchets or skin scrapers. No. 7845 is a spear head, 3·9 long by 1·8 wide. No. 7846 is a finely chipped knife, 4·9 long by 1·5 wide. This implement would generally be classed as a spear head, but its finely chipped edges and long delicate shape rather indicate its having been mounted in a short handle for use as a knife[1]. No. 7847 is probably another knife, of the general shape of the preceding, but smaller, and having two notches probably to aid in securing it to the handle. This knife is 3·6 long by 1·4 of an inch wide. No. 7848 includes four arrowpoints of common form and size. No. 7849 is probably a small spearpoint 3 inches in total length by 1·5 in width. No. 7850 is a short and broad arrowhead, with long wings or barbs and obtusely pointed. This is 1·7 in total length by 2·5 in width across the barbs. No. 7851 is a boring tool, 2·5 inches long by about ·3 to ·4 of an inch in diameter, with a short but, about 1·2 inches wide. All the above mentioned implements are made from white or slightly yellow colored flint, and show perfection of workmanship.

There are seven stone axes of ordinary size; the smallest of these being 5 inches in length by 2·8 in width; the largest is 7·8 long by 4·8 inches in width. Nos. 7827, 7830 and 7831 are of sienite, and are grooved on three sides, the fourth side being squared. In 7827 the groove passes a little to the squared or handle side, and this axe also has a more rounded cutting edge than the others. No. 7828, the largest of the lot, is of green stone and the lower part of the axe is more narrowed than in the others. No 7830 differs from the others in having a flat top, like the iron axe of the present time, and more nearly resembles

[1] There are, in the Museum, several flint knives from Europe which are very similar to this implement from Missouri, Nos. 859 and 865, from Rügen, are very close indeed as regards material, size, shape and finish of workmanship.

it in its general shape than do the others. No. 7832 is an axe of sienite, but differs from the preceding in having the groove carried all round. It is 5·7 long by 3·4 wide and 2·2 in thickness. No. 7829 is a finely carved, grooved axe, made of clay slate. The top is flat and the surface, which came in contact with the handle, is slightly concave, and the groove, which is quite deep on the opposite side, fades out gradually as it approaches this side. The front of the axe is also slightly concave, and at the same time has a curved outline from its top to its cutting edge, which is short and rounded. This axe, which is beautiful from its perfect symmetry and finish, is 6 inches in length 3·5 in greatest width just below the groove, and 2·5 in thickness. The groove is from ·8 to ·9 of an inch in width. The cutting edge is 2·5 in length. No. 7833, which is specially marked as having been found on the surface in Boone Co., is of a very unusual shape and may possibly be an unfinished implement. It is of sienite, 7·1 inches long, 3·7 wide across its upper third, 2·4 along its cutting edge, its greatest thickness 2·5. The top of the axe is flat; sides bulging; front and back edges grooved and convex in outline, the front of the axe being the most arched.

Nos. 7835 and 7836 are two hatchet-shaped implements of sienite. They are partially polished, about 4 inches long and 2·5 wide, and of the usual form of these small, or hand celts, as they are often called.

No. 7861 is a small implement of sandstone, of about the size of the last, but more triangular and with a deep groove, as if for the ball of the thumb in holding the implement in the hand.

No. 7837 is a small block of mottled greenstone such as many articles of ornament are made of. This block is 2·8 inches by 3·3, and 1·2 in thickness through the middle. It has the general appearance of a block roughly put in shape for the final purpose of making a "gorget."

Nos. 7856, 7857, and 7859 are pieces of sandstone evidently used for sharpening implements. 7859 has a number of grooves occasioned by use.

No. 7763 is a portion of the shell of *Busycon* from a small mound in New Madrid Co.

I quote from Prof. Swallow's manuscript the following account of two other mounds opened by him, and from one of which the rest of the articles here described were obtained.

"A smaller mound, 418 feet east of the south end of the Big Mound, was examined. This mound was nearly circular, 360 feet in circumference, 14 feet high, 8 feet above the present surface of the country, as 6 feet of stratified sands and clays have been deposited on the bottom since the mound was formed. In this mound were found ashes, shells, charcoal, fragments of bones and pots. Nothing of any great value.

"In Township 23, Range 15 East and Sec. 26, and about 6 miles E. N. E. of New Madrid, we opened a small mound, from which we obtained all the articles sent which are not otherwise designated. It was overgrown with trees and had not been disturbed, save in a small place on one side. This mound was circular in form.

"The pots and jars were found in a circle near the circumference, or perhaps two-thirds of the distance from the centre of the mound to the outer edge, and on the original ground beneath the mound. We found the base of the mound, when the earth was carefully removed, discolored with dark stains on the earth in the shape of a human body, with head to the pot and the feet towards the centre of the mound; also, the position of the skeleton was marked by traces of whitish, calcareous earth. We also found some fragments of the enamel of teeth just within the line of the pots where the form of the head was shown. These bodies seemed to have been placed as closely together as possible, and a pot or jar at the head of each. So regularly were they arranged that we could find them by following up the circle after we had discovered the key. There seemed to be pots in no other position in the mound. All found were in this circle.

"It appeared as if the bodies had been placed in position, and the pots and jars in their places, and then the mound built over them. In the middle of the mound we found with the earth, ashes, coal, fragments of shells (*Unionidæ*) and broken pottery. I found one *Fusus* near one of the jars in the circle.

"Everything in this mound was greatly decomposed by time and the elements, save the pots and jars of the best quality. Other pots fell to pieces as soon as they were disturbed. They have become much firmer since they were taken out.

"The best pots are made of blue clay, fine sand, and pounded shells, which materials exist in the neighborhood."

Nos. 7747, 7748, 7750, 7751 are figures of the human head in clay, and once surmounted jars like No. 7782, but of larger size. Prof. Swallow states that the jars were all broken, and the restorations,

indicated by outlines in the three woodcuts, are as correct as the fragments would permit. 7745 and 7748 are the two heads showing the most finished workmanship, and agree with 7747, and also with 7782, in having the hair or a head dress represented as an

No. 7747.

No. 7750.

ornamented band over the top of the head. 7782 and 7747 have this band represented after the same pattern, or with a central and two side projections or bunches. 7748 has a large bunch on the left side and a smaller and circular one on the right, while the

No. 7748.

centre of the band is brought over the forehead. In this head the ears are perforated, while in all the others they are not placed quite so low down and stand out prominently from the head. In 7750

the head dress represented is evidently of a more elaborate pattern than in any of the others, and looks as if the hair had been arranged in five folds of which the central one was much the largest. There is also a certain indescribable appearance to this head which gives the impression that it represents that of a man, while all the others have a feminine appearance. All the heads but 7747 have the eyes and mouth represented with distinct lids and lips, but in 7747 the bunch of clay forming the mouth has not been cut to show the lips, and that forming the left eye is also a simple round bunch placed in a depression representing the eye socket, while the bunch representing the right eye was omitted or has since fallen off. No. 7751 has the top of the head smooth, as if the individual represented had been without the usual head dress.

The following measurements will give the size and proportions of these faces.

No.	Width of face, not including the projecting part of the ears, in inches.	Distance from top of head to chin, not including the projecting part of the head dress, in inches.	Distance from root of nose to the chin, in inches.
7747	2	2·1	1·3
7748	2·15	2·2	1·5
7750	2·1	1·9	1·1
7751	2·4	2·4	1·6
7782	1·1	1·2	1·7

No. 7782 is a perfect jar with the head surmounting it and having the opening behind. This was evidently the smallest of the several jars of this character found in the mound, and is made of the blue clay, slightly mixed with sand, as are the majority of the articles of pottery found in this mound. The measurements of the face are given above. The body of the jar is spherical and with hardly any perceptible flattening below. The diameter at its largest part is from 4·5 to 4·6 inches, and the total height is 5·6 inches. The opening in the back of the head is about ·8 of an inch in diameter.

No. 7782.

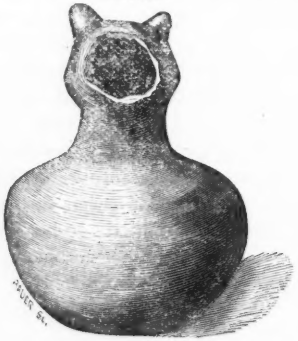
The seven following cuts represent others of this very interest-

ing series of vessels with necks and heads and with the circular opening behind.

No. 7786 is 7·4 in diameter and 7·5 inches in total height.

No. 7786.

No. 7783.



The width of the odd looking face, which may have been intended to represent that of an owl, is 2·3 inches; the "bill," or part between the eyes, projects half an inch. The apertures of these several jars are nearly of the same size, varying from about 1·3 to 1·7 inches in diameter.

No. 7783 was perhaps intended to represent some animal with projecting ears. The cuts show these ears and the opening in the back of the head. This jar is 6·1 inches in greatest diameter and 8·2 inches high.

The heads on Nos. 7781 and 7785 have the appearance of being

No. 7781.

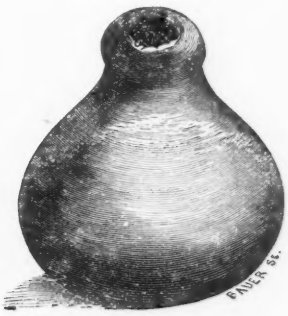
No. 7785.

left in the first stages of the design that they were to exhibit. The larger of these jars is 7·5 inches in diameter by 8·5 in height. The smaller is 4·8 in diameter by 5·6 inches in height.

No. 7784 has the appearance of the opening being in the front of the head, which is much pointed, as if the hair had been carried to a point above and dropped down the back of the neck in the form of a queue with two knots. The appearance of a high

No. 7784.

No. 7745.



forehead with a prominent nose and chin, which the woodcut gives, is not so apparent on examining the specimen, as the artist did not properly represent the narrowness of the projecting band by showing the neck upon which it rests. The height of this jar is 9 inches and its greatest diameter is 7·7 inches.

No. 7745 is one of these neck and head jars, of about the same size as 7785, but has the head part reduced to a simple spherical top without any attempt to form features.

No. 7774 is a jar of the general character of the preceding, but differs from them in being colored red, and in the whole jar being made to represent the form of a bird at rest, perhaps that of the horned owl. A front view shows the feet and projecting part of the folded wings, the large eyes, projecting feathers or "horns" of the head, and the bill, which has been broken off as shown in the cut. A back view represents the back of the head, with the aperture of the jar, the wings folded on the sides, and the pointed

tail, on which, with the legs in front, the jar firmly stands. The size of this very interesting vessel is 10 inches in height, 7 inches in diameter from wing to wing, and 6·7 inches in diameter from front to back.

No. 7774.

Col. Foster, in his Prehistoric Races of the United States, describes and figures two vessels of the same character as those mentioned above. On page 239 of his work he represents one from a mound near Belmont, Missouri, which in design is very close to those here figured as Nos. 7747, 7748 and 7750. The most interesting of his figures, however, in this connection, is that on page 243 of a "water jug found near the mouth of the Wabash." This figure shows the jar to be of the same rude design as Nos. 7783 and 7786 of the Swallow collection, and must be considered as having been made by the same people, though there is no indication of its having been found in a mound.—[*To be concluded.*

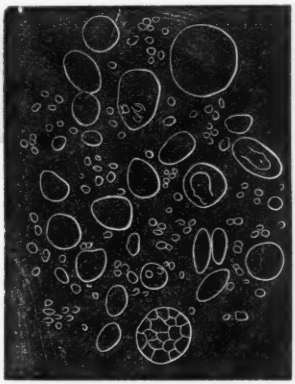
ABOUT STARCH.

BY PROFESSOR M. W. HARRINGTON.

II.

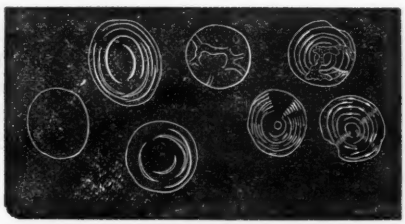
We have seen, in a former paper, that potato-starch consists of organized grains, each with a nucleus and around it a series of layers, each of which is denser than the one next within. This is the typical form of the grains of starch, but there are many variations on it. Many grains are without rings or nucleus or both. Sometimes the rings and nucleus can be brought out in these, by the action of reagents or by partial solution in any way. This is illustrated in the grains of wheat-starch. In Fig. 151 (taken from Planchon) we have the usual appearance of the starch of wheat. The largest grain at the bottom of the cut is a compound grain rare in wheat, characteristic of the starch of another group of cereals. In the typical grains we see no rings, only occasional incidental markings. In

Fig. 151.



Wheat Starch.

Fig. 152.

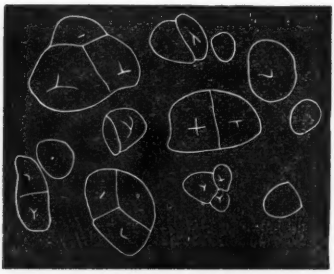


Wheat Starch.

Fig. 152 (also from Planchon), we have wheat starch after the grain from which it was taken has germinated and solution has begun. In the starch-grains of many species, however, no rings can be

made out, even with the aid of reagents. An illustration of this is the starch from the Colchicum-corm of the druggists (Fig. 153). Here we have a nucleus, often split into stellate shapes by drying, but no rings. Rings are not brought out by reagents, nor is there any cross with polarized light. In Fig. 154, which illustrates the starch of the root of aconite, we find neither nucleus nor rings.

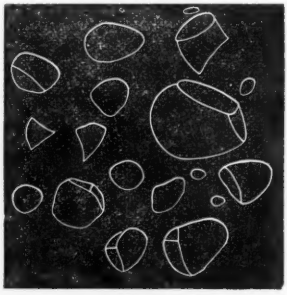
Fig. 153.



Colchicum Starch.

Starch is nourishment for the plant in a condition for preservation. We consequently find it in the thickened parts of plants, which serve as storehouses of nourishment. The starch of potato is in the tuber, a sort of thickened tip of an underground branch. In the colchicum the starch is in the corm or thickened base of the stem; in squills it is in the bulb. Rhizomes usually contain starch. That of the white water-lily is large and easily examined. The starch of the ginger rhizome is quite characteristic. That of the rhizome of sweet flag is very minute; the largest grains are hardly $\frac{1}{4000}$ of an inch in diameter. The slender rhizomes of the gold-thread contain a starch which is larger. The root often contains a large quantity of starch. The root of Stillingia of the shops is almost made up of starch. The stem of the sago-palms contains starch in immense quantities. The sago of commerce is derived from several species of them. Most barks of trees contain starch; though often in small quantities, sometimes the amount of starch is considerable in barks. Cinnamon contains a great deal. The starch may be confined to one layer of the bark, or, more abundant in one layer than in the others. In cascarilla bark, where the middle layer of the bark and the liber interdigitate, it is difficult to trace

Fig. 154.



Aconite Starch.

out the line of division between the two until iodine is added. The middle layer contains much starch, the liber little. When the iodine is added the starch turns dark and the middle layer looks like a distinct black saw, with teeth projecting into the liber. In many fruits and seeds starch is found; in the embryo of the bean and pea and in the albumen of the nutmeg, corn, wheat and rice, it is very abundant.

The strangest situation, though, in which the writer ever found starch was in the centre of a nut-gall. In the middle of the hard commercial galls (obtained from *Quercus lusitanica* Webb, var. *infectoria*, from Asia Minor), is a little, hard, nut-like case of thick-walled, stony cells. This case is filled with cellular matter when first formed. The larva of the infesting insect is found within this case, and feeds on its cellular contents. If the gall is collected when the insect has already escaped, this little nut-like sphere is empty. If the gall is picked when immature, there is some matter left in the central nut, the greater or less quantity depending on the immaturity of the gall and of the enclosed insect. This matter within the central case, on which the insect feeds, contains starch. None of the rest of the gall-tissue contains the slightest trace of it. The grains (Fig. 155) are large and flat with a distinct nucleus, and, usually, distinct rings. They produce a marked cross with polarized light. They are so large that a cell seems to accommodate only a single grain of starch.

Fig. 155.

Starch of Nut Galls.

The presence of starch in this abnormal growth suggests some interesting questions. The starch is just where the parasitic *Cynips* will eat it and nowhere else. Starch is excellent food for many animals. We eat immense amounts of it with our cereals. The sparrows live on it. Doubtless the larva of the gall-fly finds it good food. On what principle of natural selection can we account for this food being placed so conveniently for it? So far

as we can see, the *Cynips* does nothing but injury to the oak. Why should the oak provide it with choice food?

So far we have had in mind only vegetable starch. At one time it was thought that starch was peculiar to vegetables, but it has since been found in animals. In so undoubted an animal as man, starch has been found in organized granules in the brain. In appearance these grains of cerebral starch are very much like those of corn-starch. They are, however, softer.

Starch is usually found in the parenchymatous tissue of plants. Exceptionally it occurs in the elongated, tapering cells. Pocklington records in the "London Pharmaceutical Journal," the constant occurrence of starch in the wood-cells of the ipecac root of the shops. A matter analogous to starch is found as secondary layers on the cell-walls of some seeds. Schleiden calls it *Amyloid*, and gives a short list of seeds in which he has found it. A probably identical substance is found in the seeds of the common peony. The peony seeds but meagrely here, but the seeds are used somewhat in medicine, and can be found in many shops, where they have been imported from Europe. The albumen of the seeds is made up of a compact parenchyma, with moderately thick-walled cells, filled with a granular matter. On the application of a weak solution of iodine, the contents of the cells are colored a bright yellow, but the cell-walls a pure blue. If they were of cellulose, the ordinary constituent of the cell-walls, they would not be colored blue by iodine until after the action of sulphuric acid.

Starch-grains are developed by gradual growth. The different stages can be seen in most starches, from the matured parts of plants. It can be seen still better in a nearly ripe grain of corn. Every stage of the following process can be seen there. A little cavity or vacuole is formed in the protoplasmic contents of a vitally active cell. A little matter is there deposited, and becomes the nucleus. The cavity enlarges, and a layer is deposited around that already formed. Layer after layer is laid on until the grain attains a full size. This process has been watched by several observers in the fronds of *Hepaticæ*. Crüger, as quoted in the Micrographic Dictionary, says that the unsymmetrical forms of many grains is owing to the differing density of the protoplasm in which they are formed. The thicker part of a grain of potato-starch, for instance, is formed in the thicker protoplasm, while the

extended, thinner part is pushed out to where the protoplasm is less dense. It is often said that starch is especially formed in the presence of chlorophyl or the green coloring matter of plants. But we notice that it is generally deposited where there is no chlorophyl, as in the roots, underground stems, the albumen of seeds, etc. Starch is formed in protoplasm, whether there is chlorophyl present or not. When the latter is present, its tendency to collect around the solid matters of the cell, the walls, for instance, will lead it to collect about the forming starch-grain, and thus give that grain the appearance of being embedded in chlorophyl, an appearance often noted.

The form and appearance of the grains differ for each species. In nearly allied species they are much alike; in distant species, very different. Whether in all or most cases specific characters can be drawn from the grains is not fairly settled. It has never been systematically studied, so far as I know. In a few limited cases it has been done and with success. From these it is a fair presumption that specific differences in the grains exist, but are hard to recognize on account of their minuteness.

The size varies much but is tolerably constant for the same species in mature grains. The smallest measured by the writer were only 2 tt.[1] in length. They were from the rhizome of *Hydrastis Canadensis* L. Those measured were the largest grains. On the other hand the grains of potato-starch sometimes reach a length of nearly 50 tt. They are then so large that they can be distinguished by the naked eye. The grains of canna-starch are said to be even larger.

Fig. 156.

Bean Starch.

The commonest starches of commerce are the following. The figures are from Vogl.

1. *Bean-starch* (Fig. 156). The grains are in the cotyledons. They are packed in very closely with aleurone. They are of an ellipsoid or reniform shape, and are 30 tt. or less in length. The rings are usually not visible, though sometimes very evident. The nucleus is long and slit-shaped. In two of the grains figured, smaller cracks can be seen. They are caused by heating. They are easily seen by making a thin section of a bean or by simply

[1] tt = ten thousandths of an inch.

scraping off in a powder a small portion of the cotyledons. They derive their interest, not from their use in the form of starch as food, but because they have formed — or some of the closely allied starches — several almost historical quack medicines, and because they are yet frequently used in Europe to adulterate powdered medicines. The writer has found, in this country, specimens of pearl sago entirely made up of bean or pea-starch.

2. *Potato-starch* has been already figured and partly described. It derives its special interest from its universal use to adulterate powders. Commercial arrowroot, not the proprietary, is, to a considerable extent, made up of potato-starch in this country.

3. *Tapioca* (Fig. 157) is the starch of the root of *Manihot utilissima*, a poisonous Euphorbiaceous plant. The starches of some other closely related species are sometimes intermixed. The grains are small, less than 10 tt. long, shaped like a hemisphere somewhat drawn out. Viewed from the end the grain and nucleus appear round; seen from the side, the grain appears arched, and the nucleus seems to have a conical hollow space extending from it to the base of the arch. In the original condition the grains probably have the truncate ends set together, thus forming compound grains with two individuals in each.

Fig. 157.

Tapioca Starch.

In commerce, tapioca is in irregularly agglomerated masses of small size and a dead white color. These are formed by heating the grains when wet on hot plates. Sometimes the heat affects the appearance of the starch-grain, swelling it and causing it to bulge out in one or more places.

Fig. 158.

Sago Starch.

4. *Sago* (Fig. 158) is from the stem of, probably, several species of palm-trees belonging to the genera *Sagus* and *Saguerus*. It is composed of muller-shaped grains, which are rarely more than 25 tt. long.

In its original state the starch-grains are compound, consisting of one large grain with one or two quite small ones fastened to it. The component grains are separated in the preparation and we find the small ones scattered among the large. The nucleus

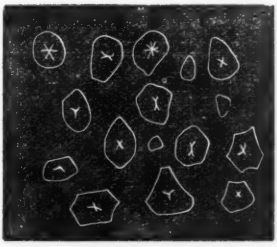
of the largest grains is dot-like, eccentric and usually quite distinct. The rings are not very apparent.

Sago, in American commerce, appears in two forms; common or brown sago, by far the most common, is found in the grocery and drug-stores in small roundish brown masses. They are little altered by heat and the grains present the characters just described.

The pearl sago is in larger spherical balls, of a dead white color. It has been subjected to heat and the grains are smaller and their nuclei are bulged out.

5. *Wheat-starch* consists of disk-shaped grains 16 tt. or less in diameter, mixed with numerous minute spherical grains. The nucleus and rings are usually not visible. Wheat-starch is now not common here as a commercial starch. In medicine and the arts it is nearly replaced by corn-starch.

Fig. 159.



Corn Starch.

6. *Corn-starch* is derived from the albumen of the grain of Indian corn. The grains (Fig. 159) are small, from 5 to 10 tt. in diameter, of an irregular form. The surface consists of partly convex, partly flat faces, the latter being formed by mutual pressure of the grains. The nucleus is star-shaped, at least when dry. There are no rings.

Corn-starch now replaces the most of the other starches, under its own name or that of maizena, maizone, etc. The *amylum* of the Pharmacopœia which calls for wheat-starch is, in every one of the many samples examined by the writer, corn-starch. As the latter is certainly as palatable as wheat-starch, and is probably more nutritious, we cannot object to the substitution except on the principle that every craft should sail under its own colors.

Fig. 160.

Arrowroot.

7. *Maranta or Arrowroot* is a name applied to a great many starches, the sort being designated by another term, as Brazilian arrowroot, referring to the tapioca-starch when in a powder. West India or Bermuda arrowroot is

the common sort in the United States. It is derived from the rhizome or underground stem of Maranta. It consists of grains (Fig. 161) with a length of 24 tt. or less. They are ellipsoid or egg-shaped with the nucleus in the centre or toward the larger end. By this character it is at once distinguished from Potato-starch, which it otherwise resembles.

The rings are easily seen, though fine. West India Maranta is often adulterated. The starches which are used to falsify it can be detected with certainty only by the microscope.

BOTANICAL OBSERVATIONS IN SOUTHERN UTAH.

BY DR. C. C. PARRY.

No. 5.

No. 143. *Nemacladus ramosissimus* Nutt. Torrey, Bot. Mex. Bound., p. 108, t. 14.

No. 144. *Utricularia vulgaris* L. Cedar City. July.

No. 145. *Phelipæa Ludoviciana* Walp.

No. 146. *Antirrhinum Cooperi* Gray. Proc. Am. Acad., vol. vii, p. 376. A slender twining plant, likely to be overlooked, collected by Dr. Cooper on the Lower Colorado in 1861; also by C. A. Almendinger in 1868; found sparingly near St. George in the shade of high basaltic cliffs. May.

No. 147. *Eunanus* ——? A slender, large flowered, showy annual, growing abundantly on gravelly hills near St. George; flowers mostly bright yellow. A light pink variety (?) was also met with later in the season.

——. *Mimulus rubellus* Gray.

No. 148. *Pentstemon ambiguus* Torrey. Marcy's Rep., t. 16. Dry sandy soil in the upper valley of the Virgen. June.

No. 149. *Pentstemon Eatoni* Gray. Proc. Am. Acad., vol. viii, p. 395. Common in all rocky gorges near St. George; also cultivated in gardens.

No. 150. *Pentstemon glaber* Pursh, var. Cedar City. July.

No. 151. *Pentstemon cæspitosus* Gray, var. Cedar City. July.

No. 152. *Pentstemon puniceus* Gray, var. *Parryi* (?). Beaver-dam mountains. May.

No. 153. *Castilleia parviflora* Bong.

No. 154. *Castilleia affinis* H. & A.

No. 155. *Cordylanthus* (*Hemistegia*) *Parryi*, n. sp. Closely resembling *C. canescens*, from which it is distinguished by its scattered greenish-yellow flowers, the bracts exceeding the calyx and corolla, the narrow erect teeth of the calyx, the tube of the corolla much shorter than the throat, and by the shorter filaments sparsely hairy. *C. canescens* has purple flowers in crowded heads, the bracts equalling the calyx and corolla, the teeth of the calyx short and spreading, the corolla-tube as long as the throat, and all the filaments naked. — Saline marshes in the valley of the Virgen. June. — S. WATSON.

No. 156. *Cordylanthus Kingii* Watson. King's Rep., p. 233, t. 22. High mountains east of Cedar City. July.

No. 157. *Nicotiana attenuata* Torr. Watson, King's Rep., p. 276, t. 27. Common in all waste places near St. George. May.

No. 158. *Nicotiana trigonophylla* Dunal. Common on rocky hills near St. George. May.

No. 159. *Audibertia incana* Benth. A very showy, strong-scented, aromatic plant, growing in clumps, 1–2 feet high. May.

No. 160. *Salazaria Mexicana* Torr. Bot. Mex. Bound., p. 133, t. 39. Not uncommon on rocky slopes adjoining the Virgen, from whence the first imperfect specimens were collected by Fremont in 1844. Flowering in May; fruit in June.

No. 161. *Salvia Columbariæ* Benth.

No. 162. *Lophanthus urticæfolius* Benth. Cedar City. July.

No. 163. *Lithospermum angustifolium* Michx. Gray, Proc. Am. Acad., vol. x, p. 51.

No. 164. *Eritrichium micranthum* Torr. Gray, Proc. Am. Acad., vol. x, p. 58.

No. 165. *Eritrichium circumscissum*. Gray, Proc. Am. Acad., vol. x, p. 58. Beautifully figured by Torrey in Bot. Wilkes' Explor. Exped., t. 12, B.

No. 166. *Eritrichium leucophæum* A. DC. Gray, Proc. Am. Acad., vol. x, p. 61. Flowers light yellow. Beaver-dam mountains. May.

No. 167. *Pectocarya luteriflora* DC.

No. 168, 169. *Eritrichium pterocaryum* Torr. Bot. Wilkes' Explor. Exped., p. 415, t. 13, B.

No. 170. *Amsinckia tessellata* Gray. Proc. Am. Acad., vol. x, p. 54.

No. 171. *Eritrichium angustifolium* Torr. Gray, Proc. Am. Acad., vol. x, p. 59.

No. 172. *Echinospermum deflexum* Lehm., var. *floribundum*. Hook. Fl. Bor.-Am., vol. ii, p. 84, t. 164. Pine valley. June.

No. 173. *Eritrichium glomeratum* DC., var. *humile* Gray. Proc. Am. Acad., vol. x, p. 61.

No. 174. *Hydrophyllum occidentale*, var. *Watsoni* Gray. Proc. Am. Acad., vol. x, p. 316. High mountains east of Cedar City. July.

No. 175. *Emmenanthe penduliflora* Benth. Upper Santa Clara valley. June.

No. 176. *Phacelia integrifolia* Torr. Gray, Proc. Am. Acad., vol. x, p. 318. Gypseous clay soil in the valley of the Virgen. May.

No. 177. *Phacelia Fremontii* Torr. One of the earliest and most showy spring flowers. March to May.

No. 178. *Phacelia Ivesiana* Torr. Inconspicuous white flowers. St. George. April.

No. 179. *Phacelia (Eutoca) cephalotes* n. sp. Gray, Proc. Am. Acad., vol. x, p. 325. On bare clay soil in the valley of the Virgen. May.

No. 180. *Phacelia crenulata* Torr. Gray, Proc. Am. Acad., vol. x, p. 318. Exposed rocky and gravelly slopes. St. George. May.

No. 181. *Phacelia micrantha* Torr. Bot. Mex. Bound., p. 144. Gray, Proc. Am. Acad., vol. x, p. 327. Crevices of basaltic rocks. April.

No. 182. *Phacelia pulchella* n. sp. Gray, Proc. Am. Acad., vol. x, p. 326. Abundant on gypseous clay hills near St. George. May.

No. 183. *Phacelia rotundifolia* Torr. In shaded crevices of perpendicular rocks. St. George. May.

No. 184. *Phacelia ramosissima* Dougl. Gray, Proc. Am. Acad., vol. x p. 319. Dry bushy plains, subscandent on low shrubs. May.

No. 185. *Nama demissa* Gray. Proc. Am. Acad., vol. viii, p. 283. A low annual, with copious red flowers set on the prostrate branches; abundant on gravelly slopes near St. George. May.

———. *Tricardia Watsoni* Torr. Watson, King's Rep., p. 258, t. 24. Only a single specimen of this interesting plant was found on the south bank of the Virgen. April.

No. 186. *Phlox canescens* Torr. & Gray. The common tufted Phlox of this region.

No. 187. *Gilia filiformis* Parry, n. sp. Gray, Proc. Am. Acad., vol. x, p. 75. Rocky slopes near St. George, April. A very delicate species, resembling in flowers and foliage some of the slender forms of *Linum*.

No. 188. *Gilia latifolia* n. sp. Annual, viscid with spreading glandular hairs, erect, 4–6 inches high, branching only above; leaves few, broadly ovate, 1–1½ inches long, rounded at the apex, narrowed below into the usually slender petiole, coarsely sinuately dentate with spinose teeth; flowers scattered in a loose panicle; bracts setaceous; calyx 2½ lines long, cleft nearly to the middle with setosely acuminate lobes;

corolla short funnel form, 3 lines long, light pink, the acute lobes half as long as the tube; filaments included, inserted below the middle of the tube; capsule oblong, many-seeded; seed not mucilaginous. — Of peculiar habit, to be included in the section *Eugilia*, but not approaching closely any of the other species. — S. WATSON.

No. 189. *Gilia Bigelovii* Gray. Proc. Am. Acad., vol. viii, p. 265. Watson, King's Rep., p. 263, t. 15, f. 3.

No. 190. *Gilia setosissima* Gray, l. c., p. 271. A very neat and ornamental species, abundant on rocky slopes near St. George. May.

No. 191. *Gilia polycladon* Torr. Bot. Mex. Bound., p. 146. Gray, l. c., p. 274.

No. 192. *Gilia floccosa*, var. Gray, l. c., p. 272.

No. 193. *Gilia congesta* Hook., var. *crebrifolia* Gray, l. c., p. 274.

No. 194. *Gilia aggregata* Spreng., var. *Bridgesii* Gray, l. c., p. 276. Pine valley. June.

No. 195. *Gilia filifolia* Nutt. Gray, l. c., p. 272. Upper Santa Clara. June.

No. 196. *Gilia demissa* Gray, l. c., p. 263.

No. 197. *Gilia leptomeria* Gray, l. c., p. 278. Watson, King's Rep., p. 270, t. 26, fig. 6–11.

No. 198. *Gilia inconspicua* Dougl. Gray, l. c., p. 278.

No. 199. *Gilia inconspicua*, var. (?). Apparently distinct from the above form. Rocky slopes, St. George. April.

No. 200. *Polemonium humile* Willd., var. Pine valley. June.

No. 201. *Lycium Andersoni* Gray. Common on rocky hills near St. George; distinguished from the following by its copious slender flowers and general habit; flowering in April; fruit in June. The bright red or amber colored berries are edible.

No. 202. *Lycium Torreyi* Gray. Low saline flats of the Virgen. With larger flowers than the former; 3 to 6 feet in height; fruit red, not edible. Flowering in May; fruit in July.

No. 203. *Frasera albo-marginata* Watson. King's Rep., p. 280.

No. 204. *Cressa Cretica* L., var. DC. Prodr., vol. ix, p. 140.

No. 205. *Cuscuta denticulata* n. sp. Stems very slender, hairlike; flowers few, in loose glomerules, on short pedicels, small (scarcely one line long), white; lobes of the deeply divided globular calyx almost orbicular, over-lapping, concave, thinly membranaceous, denticulate, covering the short campanulate (finally urceolate) tube of the corolla; lobes broadly oval, obtuse, spreading, at last reflexed, as long as the tube; scales narrow, denticulate, reaching to the base of the ovate almost sessile anthers; styles slender, as long as the conical, pointed ovary, bearing slightly thickened (scarcely capitate) stigmas; capsule covered by the withering corolla, indehiscent (?), enclosing one or two seeds. — St. George, Utah, on shrubs and herbs (Coleogyne, Biscutella) in arid soil; the first addition to our Cuscuta-flora since my synopsis was published, 16 years ago. Apparently allied to *C. applanata* Eng., of Arizona, but with much smaller flowers and an acute, not depressed ovary, different calyx, etc. — Dr. G. ENGELMANN.

No. 206. *Cuscuta Californica*, var. (?) *squamigera* Engelm. Cusc. p. 499. On *Suæda diffusa* Watson. Originally found in the same region by Remy and in Arizona by Dr. Palmer, always on saline herbs; no collector has obtained the fruit as yet. — Dr. G. ENGELMANN.

No. 207. *Asclepias leucophylla* n. sp. Erect, tall; leaves (upper) sessile with a broad cordate base, tapering to a sharp bristly point, white tomentose; umbels many flowered, alternating, lateral and terminal; pedicels a little shorter than the peduncles; calyx tomentose; corolla woolly outside; hoods as long as the short-stalked staminеal tube, slightly spreading, ovate, obtuse, rounded on the inner margin; horn from the lower part of the hood, broad, ascending, horizontally incurved over the cusps of the anthers; pollen masses lance-linear, slender, slightly curved.

Dry sandy "washes" of the Virgen River, fl. June, fruit not seen. Stem 3–5 feet high; upper leaves 3½–4 inches long, 1½–1¾ wide near the base, gradually enlarging downwards, white tomentose on both sides, becoming mottled when old. Peduncles about 1 inch, pedicels ¾ inch in length; flowers about the size of those of *A. Cornuti*, with yellowish green corolla and yellow crown. This species is closely related to two other white-woolly south-western species, viz.: *A. vestita*, H. & A., and *A. eriocarpa*

Benth.; the former of which has also long-acuminate leaves, but those of the latter are oblong and obtuse at both ends; all these have a short-stalked crown, broad ovate truncate or rounded hoods, and a short broad horn.

In *A. leucophylla* the hoods are largest and fully as long as the anther-tube, rounded and not dentate at the upper inner edge; the broad falcate horizontally incurved horns originate from the base and lower half of the hood; cartilaginous margin of anthers long, obtuse-angled at base; pollen masses slender, ¾ line or more long; pistils glabrous

In *A. eriocarpa* (Hartweg's original specimen in herb. A. Gray, Remy in Mus. Paris) the hoods are shorter than the tube, angular or forming a tooth where the upper and inner margins meet, with two distinct saccate lateral projections; the broad, falcate, horizontally incurved horns originate from the entire midrib of the hood or its upper half; cartilaginous margins of the anthers shorter, sharp-angled below; pollen masses and pistils as in the last.

In *A. vestita* (Douglas' original and Bolander's specimens in herb. A. Gray) the short hood reaches to the top of the anther-tube and has a long horizontal tooth where the upper and inner margins meet; the broad obtuse horn, incurved, but more erect and exsert than in either of the allied species, originates from the middle and lower part of the tube; cartilaginous margin of anthers short, rounded below; pollen masses only ¼ line in length, broad in proportion and more curved; pistil hairy.—Dr. G. ENGELMANN.

No. 208. *Acerates decumbens* Decne. Cedar City. July.

No. 209. *Astephanus Utahensis* n. sp. Glabrous, slender, spreading stems from a thick cylindric root; linear or filiform leaves; axillary few-flowered umbels; dull yellow minute flowers; corolla deeply campanulate with sub-erect cucullate lobes with inflexed points; follicles slender, long-acuminate, smooth; seeds scaly.—Drifting sand-hills near St. George, the fleshy roots penetrating to a great depth, giving origin just below the surface to the slender branches, that twine on adjoining shrubs or swing loosely on the scorching dry sands. Flowers in May; fruit in June.

This very peculiar little Asclepiad has its nearest relatives at the Cape of Good Hope, with one or two stray species in the West Indies and South America. The whole plant is of a grayish green color, the thick cylindric root light brown; the branching stems from less than a span to over a foot in length; leaves about one inch long, ¼ line wide; flowers about 1–1½ lines wide. The corolla is almost closed by the cucullate inflexed points of the lobes and is glandular papillose internally, so that here these lobes themselves assume the shape and perform the functions of the hoods of other Asclepiads, to allure and retain insects to assist in the fertilization of the pistil. The pendulous broadly oval pollen masses are only one-tenth of one line long; slender follicles 2–2½ inches long; comose seeds unusually rough by scale-like protuberances. —Dr. G. ENGELMANN.

No. 210. *Fraxinus anomala* Torr. Watson, King's Rep., p. 283. Common on hill-sides and sandstone ravines throughout Southern Utah. Flowers in April; fruit in June.

No. 211. *Mirabilis Californica* Gray. Bot. Mex. Bound., p. 173.

No. 212. *Abronia cycloptera* Gray. Am. Jour. Sci., Ser. 2, vol. xv, p. 319.

No. 213. *Selinocarpus diffusus* Gray. Bot. Mex. Bound., p. 168.

No. 214. *Atriplex Powellii* Watson. Revis. Chenop. in Proc. Am. Acad., vol. ix, p. 114. Saline marshes of the Lower Sevier valley; July.

No. 215. *Chenopodium Botrys* L. Waste places. St. George.

No. 216. *Atriplex expansa* (?) Watson, l. c., p. 116.

No. 217, 220. *Atriplex confertifolia* Watson, l. c., p. 119.

No. 218. *Suæda diffusa* (?) Watson, l. c., p. 88.

No. 219. *Atriplex Nuttallii* Watson, l. c., p. 116.

No. 221. *Atriplex canescens* James, var. *angustifolia* Watson, l. c., p. 120.

No. 222. *Grayia polygaloides* H. & A. Watson, l. c., p. 122.

No. 223, 224. *Kochia Americana* Watson, l. c., p. 93.

No. 225. *Eurotia lanata* Moquin. Watson, l. c., p. 121.

No. 226. *Parietaria debilis* Forst. On steep basaltic rocks. St. George. May.

No. 227. *Polygonum cuarctatum* Dougl. DC. Prodr., vol. xiv, p. 101.

No. 228. *Oxytheca perfoliata* Torr. & Gray. Watson, King's Rep., p. 311. t. 34. fig. 1. Common on gravelly table-lands. St. George. May.

No. 229. *Pterostegia drymarioides* F. & M. Torr. & Gray. Revis. Eriog. in Proc. Am. Acad., vol. viii, p. 200. Shaded rock crevices. April.

No. 230. *Chorizanthe brevicornu* Torr. & Gray. l. c., p. 196.

No. 231. *Chorizanthe rigida* Torr. & Gray, l. c., p. 198.

No. 232. *Centrostegia Thurberi* Gray. Torr. & Gray, l. c., p. 192. Upper Santa Clara valley. June.

No. 233. *Eriogonum racemosum* Nutt. Torr. & Gray, l. c., p. 175. Lower Sevier valley. June.

No. 234. *Eriogonum fasciculatum* Benth. Torr. & Gray, l. c., p. 169. Rocky crevices. St. George. June.

No. 235. *Eriogonum angulosum* Benth. Torr. & Gray, l. c., p. 187.

No. 236. *Eriogonum inflatum* Torr. Torr. & Gray, l. c., p. 185. Rocky hills. St. George. May.

No. 237. *Eriogonum reniforme* Torr. Torr. & Gray, l c., p. 184.

No. 238. *Eriogonum Thomasii* Torr. Torr. & Gray, l. c., p. 184. Forming large patches on exsiccated alluvial soil, in the valley of the Virgen. May.

No. 239. *Eriogonum Parryi* n. sp. Gray, Proc. Am. Acad., vol. x, p. 77. Rocky slopes near St. George, May; very variable in size, in robust specimens the leaves fully two inches broad.

No. 240. *Eriogonum trichopodum* Torr. & Gray, l. c., p. 185. One of the common gregarious species, which in the season of flowering in the latter part of May, gives a peculiar yellowish green color to the hills adjoining St. George.

No. 241. *Eriogonum ovalifolium* Nutt. Torr. & Gray, l. c., p. 164. Beaver-dam mountains. May.

No. 242, 244. *Eriogonum microthecum* Nutt. Torr. & Gray, l. c., p. 170. Cedar City. July.

No. 243. *Eriogonum villiflorum* Gray. Proc. Am. Acad., vol. viii. p. 630. Cedar City. July.

No. 245. *Eriogonum spathulatum* n. sp. Gray, Proc. Am. Acad., vol. x, p. 76. Lower valley of the Sevier. July.

No. 246. *Rumex hymenosepalus* Torrey. Bot. Mex. Bound., p. 177. Abundant on dry sandy or rocky slopes near St. George; the young tender shoots in domestic use as a substitute for rhubarb. May.

——. *Shepherdia rotundifolia* n. sp. Silvery tomentose and scurfy; leaves persistent, round-oval or ovate, mostly somewhat cordate, shortly petioled, beneath densely stellate-white scurfy, as well as the branches, above less scurfy and greenish; flowers all in the axils of ordinary leaves, on pedicels about the length of the perianth, the male flowers mostly in threes and the female solitary; filaments very short, glabrous; fruit globular, scurfy; akene ovate, unequally channelled at base.—On bare clay soil in the upper valley of the Virgen, A. L. Siler, 1873. Forming low densely branched bushes with dull-colored evergreen foliage; flowering in March, perfecting its fruit in July.

No. 247. *Euphorbia Parryi* n. sp. Annual, erect, slender, pale-green, glabrous, with dichotomous spreading branches; leaves linear, nearly equal at base, acutish or acute at both ends, with setaceously slit stipules; involucres campanulate, on moderately long peduncles in the forks of the branches, with unequal small truncate appendages; styles short, somewhat erect; capsule sharp-angled; seeds ovate, minutely granulate. —— St. George, in loose drifting sand. Plant about a span in height; leaves ½–1 inch long, ½ line wide, rolled inward when drying; involucres ¾–1 line long, and with the greenish-white appendages of the same width; stamens numerous, with conspicuous feathery bracts between them; styles about the length of the ovary; seeds ¾ line long, rather thick, obtusely angled, surface covered with minute granules, disposed in transverse lines. Habit very similar to *E. revoluta* Engel., but this has a dark purplish-green color, revolute not involute leaves, very much smaller, slender turbinate involucres on short peduncles, and smaller, sharp-angled, strongly cross-ribbed seeds. The charac-

ters of our species point to an alliance with *E. zygophylloides* Boiss. — Dr. G. ENGELMANN.

No. 248. *Celtis occidentalis* L., var.

No. 249, 251. *Ephedra antisyphilitica* C. A. Meyer. Watson, King's Rep., p. 238, t. 39.

No. 250. *Ephedra trifurca* Torr. Watson, l. c., p. 239. Not uncommon on bare saline wastes in the valley of the Virgen. May.

No. 252. *Allium Palmeri* Watson. King's Rep., p. 487, t. 37, fig. 10–11. High mountains east of Cedar City. July.

No. 253. *Androstephium breviflorum* Watson. Am. Naturalist, vol. vii, p. 303. Common on rocky hills near St. George. April.

No. 254. *Calochortus flexuosus* Watson, l. c., p. 303. A fine large-flowered species, which on account of its branching habit continues to put forth its showy tulip-like flowers for several weeks. May.

No. 255. *Calochortus Nuttallii* Torr. & Gray. High mountains east of Cedar City. July.

No. 256. *Milla capitata* Baker, var. *pauciflora* Torr. Watson, King's Rep., p. 490.

No. 257. *Yucca brevifolia* Engel. King's Rep., p. 496. Beaver-dam mountains; flowering in May. See above, Am. Naturalist, vol. ix, p. 141.

No. 258. *Anemopsis Californica* H. & A. Bot. Beechey, p. 390, t. 92.

No. 259. *Polypogon Monspeliensis* Desf. Frequent on the borders of ditches, St. George. June.

No. 260. *Tricuspis pulchella* orr. Bot. Whip. Rep., p. 156.

No. 261. *Aristida purpurea* Nutt. Steud. Gram. p. 134.

No. 262. *Adiantum Capillus-Veneris* L. Moist rocks about springs near St. George.

——. *Notholæna tenera* Gillies. Crevices of perpendicular limestone rocks in a deep ravine near the base of Beaver-dam mountains, twelve miles southwest of St. George, May. Hitherto found only in Chili and Bolivia. The present specimens are smaller and more delicate than those from S. America, but not otherwise different. From *N. Fendleri* and *N. dealbata* it may be distinguished by the oblong outline of the frond and the entire absence of white powder beneath. — Prof. D. C. EATON.

No. 263. *Notholæna Parryi* n. sp. Caudex short, inclined, laden with rather rigid lance-acuminate fulvous scales having a blackish mid-rib; stipes 1½–3 inches long-tufted, dark brown, minutely striated, pubescent with white articulated often gland-bearing hairs; fronds as long as the stipes, oblong-lanceolate, about tripinnate, lower pinnæ distant; segments crowded, roundish obovate, about one line long, densely covered above with entangled white hairs like those of the stipe, and beneath with a similar pale-brown tomentum; sporangia blackish, when ripe projecting beyond the margins of the segments. — Crevices of basaltic rocks near St. George. April. — Prof. D. C. EATON.

——. *Æcidium biforme* n. sp. Peridia clustered, some short with a wide entire mouth, others elongated with the mouth more or less lacerated, the wall-cells mostly pentagonal or hexagonal; spores sub-globose, golden yellow, .0007 to .0008 inch in diameter. — Parasitic on both sides of a leaf of *Heliotropium Curassavicum* L., St. George, May. The peculiar feature of this species is in the peridia, which are either long or short, and equally abundant on both sides of the leaf, projecting each way from the same subiculum. — C. H. PECK.

ERRATA.

Page 16, 13th line from bottom, for *Phacelia crassifolia* Torr. read *Phacelia pulchella* n. sp.
Page 16, 7th line from bottom, for *Phacelia curvipes* n. sp. (?) read *Phacelia cephalotis* n. sp.
Page 16, 6th line from bottom, for *P. Palmeri* Torr. read *P. integrifolia* Torr.
Page 18, 10th line from top, for *Culochortus* read *Calochortus*.
Page 18, 18th line from top, for *Capillus-venesis* L. read *Capillus-Veneris* L.
Page 20, 15th line from bottom, for *polygalvides* read *polygaloides*.
Page 201, 11th line from bottom, for *Trifolium Bolanderi* read *Trifolium Kingii*.

BIOGRAPHIES OF SOME WORMS.

BY A. S. PACKARD, JR.

RETURNING from our journey through the subkingdom of the Mollusca, we will follow the path leading from the Worms up to the Insects. The lowest worms are far more simple in structure than the lowest mollusks. Indeed in organisms like the Vortex, for example, we have forms which serve as a point of departure, ancestral forms, from which the entire animal world above the Infusoria may have been originally derived.

The division of worms is now so vast and unwieldy that it seems impossible to give a general definition of it, and in the present state of science it may be unnecessary. The group embraces all grades of development from simple ciliated forms like the Vortex, Prostomum and Macrostomum, which are scarcely more complicated than the ciliated infusoria, differing chiefly in having genuine cells composing the tissues, up to animals like the earth worms and nereids which are in some respects as high if not higher than the Crustacea and insects.

Claparède in his "Beobachtungen," etc., says that "the Rhabdocœla have interested me on account of their undeniable passage to the ciliated Infusoria. I am truly of Agassiz's opinion that many so-called Infusoria may be simply Turbellarian larvæ; although at first opposed to this opinion I afterwards expressed my views as to the near relationship of the Infusoria as well with the Rhabdocœla as the Dendrocœla. Thus as *Trachelius ovum* forms an evident connecting link between the Infusoria and Dendrocœla, so are the early stages of the Rhabdocœla often scarcely to be distinguished from the Infusoria. In many cases one is in doubt whether he is dealing with a young Turbellarian worm or a ciliate Infusorian." He then describes an Infusorian-like worm in which the mouth opens by a pharynx into a broad body and digestive cavity, with no anal opening. There is thus no digestive cavity separated from the body cavity. There are no other organs except an otolite. This is evidently an immature form, but none the less closely allied structurally to Paramecium and Trachelius.

It should also be remembered that among the worms are many synthetic types which, as regards some organs, remind us of other groups of animals. For example the Rotifers recall the lower Crustacea, and are by some naturalists regarded as such; the Planarians have been considered by Girard, as mollusks, the Polyzoa and Brachiopods are still regarded as mollusks by eminent naturalists, and there are very few who do not place the Tunicates among the latter. On the other hand the Echinoderms are regarded as worms by some, and Amphioxus has been called a worm. Indeed if any one has any prejudices regarding fixed types in nature, and would learn how regardless of preconceived zoological systems the actual state of our knowledge of the lower animals must lead one to become, let him study the animals now placed among the "Worms."

Leaving out of consideration the lowest forms, almost without organs, and many parasitic forms, as a general rule the worms are bilateral, segmented animals with the nervous cords either separate or united by commissures, and resting on the floor of the body under the alimentary canal, which usually (when present) passes directly through the middle of the body. There is in the Annelides a dorsal and ventral blood-vessel, the circulatory apparatus being closed and more highly developed than in the Crustacea and Insects, Limulus excepted. In the lower worms (Platyelminths, Nematelminths, Acanthocephali and Rotatoria) there is a complicated system of excretory tubes, thought by some anatomists to be analogous with the water-vascular system of Radiates.

The organs of locomotion are, when present, simple bristles or prolongations of the walls of the body forming paddle-like flaps.

We are now concerned with tracing the mode of development of some of the typical forms belonging to the different subdivisions, the general relations of which may be seen in the following tabular view, which is taken from Gegenbaur's "Principles of Comparative Anatomy," with the addition of the Brachiopoda, which he still retains among the Mollusca. The Onychophora, represented by Peripatus, are also omitted, as since the publication of Gegenbaur's work, Peripatus has been proved by the researches of Mr. Moseley to be a tracheate Insect.

VERMES.

I. PLATYELMINTHES.
- *Turbellaria* (Vortex, Prostomum, Planaria).
- *Trematoda* (Distoma, Monostomum).
- *Cestoda* (Tænia, Bothriocephalus).
- *Nemertina* (Nemertes).

II. NEMATELMINTHES.
- *Nematodes* (Strongylus, Ascaris).
- *Gordiacea* (Gordius, Mermis).

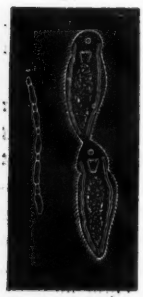
III. CHÆTOGNATHI (Sagitta).
IV. ACANTHOCEPHALI (Echinorhynchus).
V. ROTATORIA (Brachionus, Rotifer).
VI. POLYZOA (Alcyonella, Flustra, Lepralia).
VII. ENTEROPNEUSTI (Balanoglossus).
VIII. TUNICATA (Appendicularia, Ascidia, Pyrosoma, Doliolum, Salpa).
IX. GEPHYREA (Sipunculus).
X. BRACHIOPODA (Lingula, Terebratulina).
XI. ANNULATA (Hirudo, Lumbricus, Nereis, Serpula).

I. PLATYELMINTHES (Flat Worms, Flukes and Tape Worms).

These are flat-bodied ciliated worms without lateral appendages, usually with hooks or suckers. They are usually hermaphroditic.

Development of the Turbellaria. These lowest of worms, in which there is no true stomach and intestines, but a simple short blind digestive sac leading from the mouth and pharynx, are known to multiply by fission, the body dividing into two. They also possess ovaries and male glands, and reproduce from eggs. We are not acquainted with the life-history of the Rhabdocœlous forms, such as Vortex, Prostomum, etc., except that we know that they produce eggs and spermatic particles. In Prostomum, an orbicular form, the yolk cells are formed in a gland (vitellogene) distinct from the true ovary or germ-forming gland (germogene). As an example of reproduction by fission may be cited the singular *Catena quaterna* Schmarda, which occurs in fresh water at the Cape of Good Hope. Fig. 161 represents two individuals in partial division, and a chain of four individuals, natural size. This form reminds us of the tape worm, in

Fig. 161.



Catena quaterna.

which the joints remain permanently attached. We know nothing further regarding the history of Catena except that it has been found as indicated in the figure here reproduced from Schmarda.

Among the Dendrocœla, or Planarians, and in fact in the flat worms generally, fission takes place. If we cut the common fresh water Planarians into several pieces, each piece will become a perfect worm.

All the fresh water flat worms are born as infusorian-like ciliated bodies which attain maturity without any metamorphosis. As an example of the mode of development of a Planarian worm, may be given the history of *Planocera elliptica* discovered by Girard in Boston and Beverly harbors. The spawning time lasts from the middle of May until the middle of June, the eggs being deposited in a thin viscid band on stones and sea weeds. The egg undergoes total segmentation in four or five days after. A ciliated blastoderm begins to form around the yolk mass, and before the embryo leaves the egg it assumes the larval shape, being an infusorian-like form, with a caudal flagellum. There are no internal organs except two eye-specks.

In eight or ten days after the larva begins to revolve in the egg, and after it has hatched, it stops swimming about and becomes a "mummy-like body" which Girard calls a "chrysalis." In this condition, which apparently corresponds to the encysted state of the flukes, it floats about in the water. Here Girard's observations came to an end. Whether in this resting stage it is swallowed by some other animal, and becomes a parasite before resuming its active life, remains to be seen.

The later history of *Planaria angulata* has been traced by Mr. A. Agassiz. "On examining," he says, "a string of eggs, mistaken at first for those of some naked mollusk, I was surprised to find young Planariæ in different stages of growth with a ramifying digestive cavity, somewhat similar to that of adult specimens, but showing besides, one distinct articulation for each spur of the digestive cavity. The eyes were well developed, and when the young became free, the articulations were still distinct." In the youngest specimen (Fig. 162) observed, the body was almost cylindrical, while as seen in Fig. 163, the body has become considerably flattened. The fact that before attaining maturity the Planarian is articulated is very significant, showing that these low worms, non-segmented in maturity, should not be excluded

from the class of worms, and that the terms "bilateral, articulate" applies as well to the lowest division (though with many exceptions) of worms as to the true Annelides.

Fig. 162.

Fig. 163.

Young Planaria.

The Turbellaria then, so far as our limited knowledge extends, develop (*a*) by fission, (*b*) from eggs fertilized by sperm cells, and pass through the following stages, not, however, all observed in a single species.

1. Morula.
2. Infusorian-like stage.
3. A quiet, encysted (?) stage (Girard's Planocera).
4. Articulated stage observed in one species (Agassiz's *Planaria angulata*).
5. Adult, ciliated, not segmented.

Development of the Trematodes. The flukes are parasitic worms, with a sucking disk in the centre of the body by which they attach themselves on or within the body of their host. The fluke or "liver worm" (*Distoma hepaticum*) lives in the liver of the sheep and of man. The fishes and snails are much infested by them, nearly each species having its distinct kind of fluke. The adult flukes are not ciliated, the alimentary canal ends in a blind sac, and the sexes are united in the same individual.

For the mode of formation of the egg of the Trematodes, and the embryonic history of certain forms, the student is referred to Leuckart's "Menschlichen Parasiten" and E. Van Beneden's beautiful "Researches." E. Van Beneden has shown that the development of the Trematodes begins by subdivision of the germinative cellule or nucleus. The nucleus and nucleolus then divide and subsequently the "protoplasmic body." The yolk, however, remains entirely independent of this division, and serves as nourishment for the other cells forming the body of the embryo.

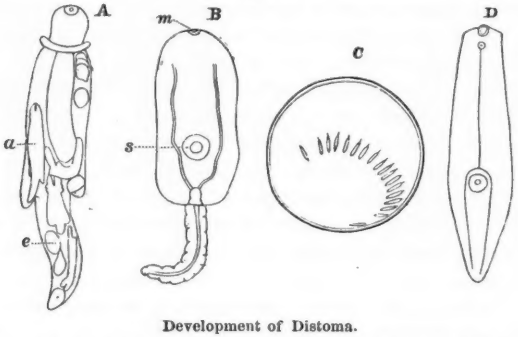
From Van Beneden's observations, it appears that the eggs of the lower flukes as a rule undergo total segmentation, and the young are hatched either oval, ciliated, Infusorian-like, without any organs, not even eye-specks, as in Distoma and Amphistoma; or as in the higher Trematodes, as shown by the elder Van

Beneden, the development is direct, the embryo passing directly into a form like the adult.

For the further history of the fluke we will turn to Steenstrup's famous work "On the Alternation of Generations," wherein is first related the strange history of these animals. While the flukes were well known, as well as the tadpole-like Cercaria, it was not known before the publication of Steenstrup's work in 1842, that the Cercariæ were the free larval forms of the Distomæ. The *Cercaria echinata*, first described by Siebold, is like a Distoma except that the body is prolonged into a long extensible tail. This tail, says Steenstrup, is formed of several membranes or tubes placed one within the other, of which the outermost is a very transparent epidermis, under which is a tolerably thick membrane furnished with transverse muscular fibres or *striæ*, and between each pair of these transverse fibres is placed a globular vesicle which appears to be a mucous follicle or gland; the innermost tube is opaque and of firmer consistence, it contains the longitudinal muscular fibres, and is usually reticulated on the surface. Through the centre of these tubes there passes a slightly narrower canal, which becomes very small towards the extremity of the tail. The existence of the same layers in the body itself of the Cercaria, can easily be demonstrated; but the transversely striated layer is here not so much developed. This description of the Cercaria will remind one of the tadpole-like larva of the Ascidians. The apparent homology in structure of the tail of the Cercaria with that of the Ascidian larva as figured by Kupffer, is striking. This similarity may be seen if the reader will compare fig. 7, Tab. ii, in De la Valette St. George's "Symbolæ," representing a stage in the development of *Cercaria flava* into *Monostomum flavum*. The author figures a row of cells on each side of a central cavity through which passes what is regarded as possibly a nerve. Whether this is not as much a *chorda dorsalis* and spinal nerve as those parts regarded as such in the Ascidian larva, is a subject for future investigation. But in other respects the position of the mouth, the sense-organs, as well as the form of the body strikingly recall the Ascidian larva, so much so that it gives strong confirmation to the opinion that the Ascidians are worms, and that they and the Trematodes have possibly originated from allied forms. In another species, *Cercaria ocellata*, the tail has a lateral fin; and in still another species figured by J. Müller

on the same plate (*Cercaria setifera*) unaccompanied by any description, the tail contains an axial row of large cells, with a row on each side reminding one of the embryo of the Ascidian, with its axial row of cells (the germ of the *chorda dorsalis*) and the

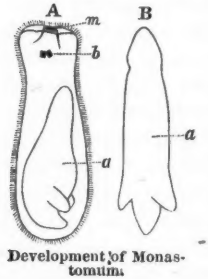
Fig. 164.



Development of Distoma.

cells on each side; moreover the tail is provided with nineteen pencils of long hairs, each pair arising from a distinct segment, so that in one larval Trematode at least, the annulated structure of the body exists, as well as in the larval Planaria.

Fig. 165.



Development of Monastomum.

Returning now to Steenstrup's narrative, he tells us that these "Echinate Cercariæ (Fig. 164, A, parent nurse; *e*, germs; *a*, nurse; B, larva), are found by thousands, and frequently by millions in the water, in which two of our largest freshwater snails, *Panorbis cornea* and *Limnæus stagnalis*, have been kept." After swimming about in the water some time they fix themselves by means of their suckers (B, *s*) to the slimy skin of the snails, in such numbers that the latter look as if covered with bits of wool.

The Cercaria by contracting its body and violent lashing of the tail forces its way into the body of its host, loses its tail, and then resembles a mature Distoma. By turning about in its place and secreting a mucus, a cyst is gradually formed, with a spherical shell. This constitutes the "pupa" state of the Cercaria, first

observed by Nitzsch and afterwards by Siebold. Steenstrup thinks that the Cercaria casts a thin skin. In this state the body can be seen through the shell of the cyst, as in Fig. 164, C, where the circle of spines embedded around the mouth is seen.[1] The encysted Cercariæ remain in this state from July and August until the following spring; and during the winter months in snails kept in warm rooms, they change into Distomas (Fig. 164, D) the mature fluke differing, however, in some important respects from the tailless larvæ. In nature they remain from two to nine months in the encysted state.

"Now," asks Steenstrup, "Whence come the Cercariæ?" Bojanus states that he saw this species swarming out from the "king's yellow worms," which are about two lines long and occur in great numbers in the interior of snails. From these are developed the larval Distomas, and Steenstrup calls them the "nurses" of the Cercariæ and Distomata. They exactly resemble the "parent nurses" (Fig. 164, A) and like them the cavity of the body is filled with young, which develop from egg-like balls of cells. Steenstrup was forced to conclude that these nurses originated from the first nurses (Fig. 164) which he therefore calls "parent-nurses." Here the direct observations of Steenstrup on the *Cercaria echinata* came to an end, but he believed that the parent-nurses came from eggs. The link in the cycle of generations he supplied from the observations of Siebold, who saw a Cercaria-like young (Fig. 165, B) expelled from the body of the ciliated larva of *Monostomum mutabile* (Fig. 165, A, *a*, nurse developing from ciliated larva; *m*, mouth; *b*, eye specks). Steenstrup remarks that "the first form of this embryo is not unlike that of the common ciliated progeny of the Trematoda, as they have been known to us in many species for a long time, from the observations of Mehlis, Nordmann and Siebold, and it might at first sight be taken for one of the polygastric infusoria of Ehrenberg, which also move by cilia; whilst in the next form which it assumes the young Monostomum bears an undeniable resemblance to those animals which I have termed 'nurses' and 'parent nurses' in that species of the Trematoda which is developed from the *Cercaria echinata*."

Thus the cycle is completed and the following summary of

[1] Other figures by Steenstrup and other authors show the form of the encysted Cercaria very distinctly, but in the figure given above only the spines are distinctly represented in the plate from which this is copied.

changes undergone by the lower Distomas present as clear a case of an alternation of generations as seen in the jelly fishes.

1. Egg.
2. Morula.
3. Ciliated larva.
4. Cercaria (parent nurse, Proscolex) producing
5. Cercaria (nurse, scolex).
6. Encysted Cercaria (Proglottis).
7. Distoma (Proglottis).

The *Cercaria echinata*, living in snails which are eaten by ducks, have been shown by St. George to develop into the adult Distoma in the body of that bird. It is generally the case that those Distomas which pass through an alternation of generations live in the larval state in animals which serve as food for higher orders. Thus the Bucephalus of the European oyster passes in the encysted state into a fish (Gasterostomum), which serves as food for a larger fish, *Belone vulgaris*, where the cysts of the same worm occur.

Distoma hepaticum, the liver fluke, sometimes occurring in man, is thought by Dr. Willemoes-Suhm to begin its existence as *Cercaria cystophora*, parasitic on a species of Planorbis.

LITERATURE.

Steenstrup. On the Alternation of Generations. 1842. Translated by G. Busk, 1845.
De la Valette St. George. Symbolæ ad Trematodum Evolutionis Historiam. Berlin, 1855.
Leuckart. Die Menschlichen Parasiten. Leipzig. 1868, incomplete.
E. Van Beneden. Recherches sur la Composition et la Signification de l'Oeuf. Bruxelles, 1870.

Development of the Cestodes. In the tape worm there is no alimentary canal, the liquid food being absorbed from the juices of its host through the walls of the body. The head is armed with suckers, hooks or leaf-like soft appendages, while the body is subdivided usually into a great number of segments, each containing an ovary and male gland. While the Turbellaria possess a pair of nerve-ganglia, the Cestodes are not known positively to possess any trace of a nervous system.

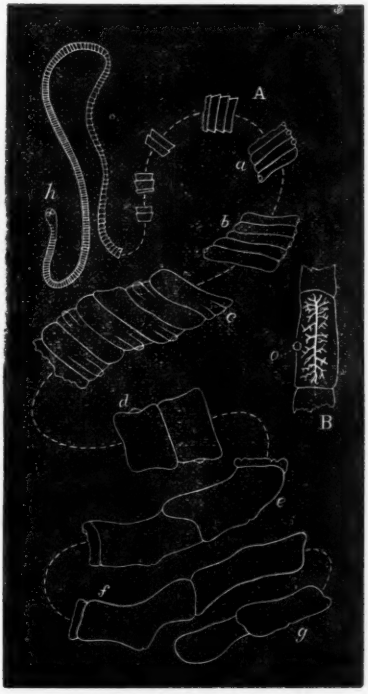
E. Van Beneden shows that the egg is formed by two glands, one of which (the germogene) forms the nucleus and nucleolus, while the other (vitellogene) forms the yolk. Development begins very probably as in the Trematodes, by multiplication by division of the nucleus (germinative cell). In the eggs of *Tænia bacil-*

laris E. Van Beneden saw the nucleus subdivide; afterwards the cells are arranged in two layers, and the outer layer is thrown off (this probably corresponding to the amnion of insects and crustacea); the central mass forms the embryo, and soon the three pairs of hooks arise as in Fig. 166. Three structureless membranes are secreted around the embryo, which then hatches. The embryo of Bothriocephalus is provided with a ciliated membrane, which corresponds to the first blastodermic moult of the embryo Tænia, which is not ciliated.

Fig. 166.

Embryo of Tænia.

Fig. 167.



Common Human Tape worm.

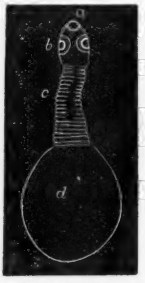
Now taking up the history of the human tape worm, *Tænia solium* (Fig. 167[1]), the eggs eaten by the hog are developed in its body into the larval tape worm (scolex) called in this species, *Cysticercus cellulosæ*, (Fig. 168; Fig. 169, head enlarged). The head with its suckers is formed, the body becomes flask-shaped (Fig. 168, Cysticercus); the Cysticerci then bury themselves in the liver or the flesh of pork, and are transferred living in uncooked pork to the alimentary canal of man. The body now elongates,

[1] *Tænia solium*. A, the worm natural size; *h*, head; *a*, 309th joint; *b*, 448th; *c*, 569th; *d*, 680th; *e*, 768th; *f*, 849th; *g*, 855th joint and last but one. This worm was 10 feet 9 inches long. B, a separate joint (Proglottis) showing the ovary with its outlet *o*; the same joint contains a testis, too minute to show in the figure. Fig. 168, *Cysticercus cellulosæ*. the larval tape worm, *a*, circle of hooks; *b*, suckers; *c*, wrinkled neck; *d*, sac filled with fluid. This and Fig. 166 and 169 from Weinland.

new joints arise behind the head until the form of the tape worm is attained, as in Fig. 167, after Weinland.

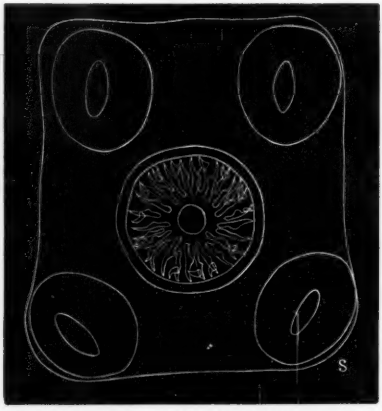
Now we shall see how the eggs are produced. The hinder joints become filled with eggs and then break off, becoming independent animals comparable with the "parent-nurses" of the Cercarias, except that they are not contained in the body of the Tænia (as in the Cercaria), but are set free. The independent joint (Fig. 167, *g*, is called a "proglottis." It escapes from the alimentary tract, and the eggs set free are swallowed by that un-

Fig. 168.



Cysticercus, or larval Tape worm.

Fig. 169.



Head of Cysticercus enlarged, showing the suckers (S) and circle of hooks.

clean animal, the pig, and the cycle of generations begins anew. We thus have the following series of changes which may be compared with the homologous series in the flukes:

1. Egg.
2. Morula.
3. Double-walled sac (Planula?).
4. Proscolex, free embryo with hooks, surrounded by a blastodermic skin (Amnion?).
5. Scolex (Cysticercus, larva). Body few-jointed.
6. Scolex (Tænia). Body many-jointed.
7. Proglottis (adult).

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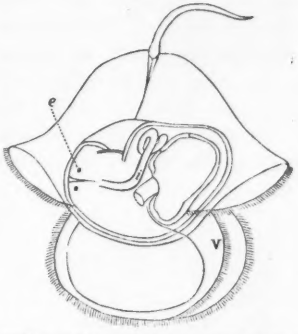
P. J. Van Beneden. Les Vers Cestoïdes. Brussels. 1850.
——— ——— ———. Memoire sur les Vers Intestinaux. Paris. 1858.

Siebold. Ueber die Band- und Blasenwürmer. Leipzig. 1854.
Weinland. An Essay on the Tapeworms of Man. 1858.
Compare also the works of Leuckart, Küchenmeister, E. Van Beneden and Cobbold.

Development of the Nemerteans. In the development of some of these worms we are reminded of the mode of growth of the Echinoderms, while in others the larvæ attain the adult condition by gradual development. In no order of animals, perhaps, is there a greater range of variation in the mode of development than in these curious worms.

The simplest mode of growth is that described by Dieck in Cephalothrix, where the ciliated larva, after passing through a morula and planula[1] stage (being a two-layered sac, but not a gastrula) leaves the egg and undergoes no metamorphosis, the young worm having no body cavity. In the Nemertes larva of Desor there is a body cavity, but the larva is still an infusorian-like being, and attains maturity by direct growth. Another Nemertean (*N. communis*) has been found by Barrois to have a somewhat more complicated mode of growth than in the larva of Desor. The first stages of development are like those of the larva of Desor, the morula passing, as he claims, into a ciliated "gastrula" state in the egg, the body cavity being formed by invagination of the outer layer of cells, but the animal after shedding an amnion leaves the egg in the Nemertes form, and there is no free swimming stage.

Fig. 170.



Pilidium with the Nemertes growing in it.

Now we come to those Nemerteans in which there is a very complicated metamorphosis. J. Müller had described an animal caught with the towing net which he called "Pilidium." Busch had suspected that a Nemertes came from the Pilidium, and Leuc-

[1] The inner lining of the planula arises before the body cavity is formed, by a differentiation of a second inner cell-layer, as occurs in other worms, zoophytes, etc. Dieck evidently limits the term gastrula to a two-layered sac, with a body cavity formed by the invagination of the ectoderm Lankester's "gastrula" includes any embryo with a two-layered sac and a primitive cavity. Dieck's planula is like Hæckel's planula of the sponge, the cavity being formed during the segmentation of the egg.

kart and Pagenstecker proved it. Our figure taken from the drawings of these two last named authors shows the singular Pilidium, and the planarian-like Nemertes with the eye-specks (Fig. 170, *e*), growing in it. How the worm originates in the body of the Pilidium, and how the latter arises, have lately been fully shown by Metschnikoff, and to his memoir we are indebted for the strange history of the alternation of generations in these worms.

He followed the development of the Pilidium from the egg, which undergoes total segmentation, leaving a segmentation-cavity. The next occurrence is the separation of a one-layered ciliated blastoderm, the ectoderm, which invaginates, forming the primitive digestive cavity, from which the stomach and œsophagus are formed. The larva is now helmet-shaped, ciliated, with a long lash (flagellum) attached to the posterior end of the body.

After swimming about on the surface of the sea awhile, the Nemertes begins to grow out from near the œsophagus of the Pilidium. On each side of the base of the velum (*v*) of the Pilidium appear two thickenings of the skin, one pair in front, the other behind; these thickenings push inwards, and are the germs of the anterior and posterior end of the future worm. The anterior pair become larger than the posterior; the part of the disk next to the œsophagus thickens; at the same time the alimentary canal of the Pilidium grows smaller and only a narrow slit remains. The disks now divide into two layers, the outer much thicker than the inner. A new structure now arises, a pair of vesicles near the hinder pair of disks; these are the "lateral organs" of the future worm. Soon the anterior pair of disks unite and the head of the worm is soon formed, when the elliptical outline of the flat worm is indicated, and appears somewhat as in Fig. 170 (*i*, intestine of the worm). The yolk mass, with the alimentary canal of the Pilidium, is taken bodily into the interior of the Nemertes, the Pilidium skin falls off, and the worm seeks the bottom.

Metschnikoff discovered five other species of Pilidium, and thinks this mode of development is not an uncommon occurrence. This manner of development is directly comparable with that of the echinoderm from the Pluteus.

To show the wide range of metamorphosis existing in the Nemerteans, we may cite the case of a Nareda studied by Mr. A. Agassiz, and whose early stages are like those of the higher Annelides, in fact so much so that Milne-Edwards and Claparède

Fig. 171.

a

Fig. 172.

Fig. 174.

Fig. 173.

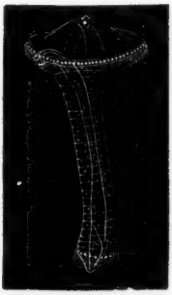
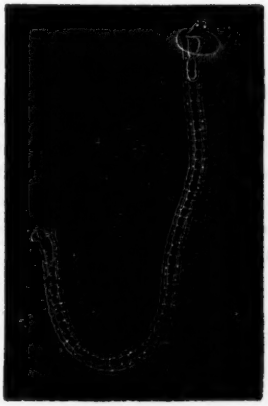
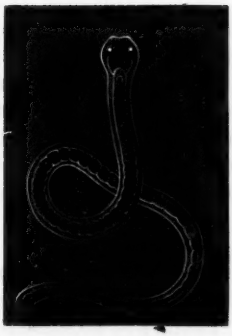


Fig. 176.

Fig. 175.





Development of a Nemertean worm. After A. Agassiz.

associated "the larva of Lovén" (which Mr. Agassiz has traced without any doubt to the Nemertean worm) with that of Polynoë, a representative of the highest family of Chætopod worms. In the first stage (Fig. 171, *a*, anus; *c*, intestine; *m*, mouth; *o*, œsophagus; *s*, stomach; *e*, eye-speck; *v*, ciliated ring) the larva is not ringed; this figure may be compared with figure 96 on p. 231 to show how much alike the worm and Echinoderm larvæ appear. The new rings are formed between the anal rings and the older anterior rings, as in annelid larvæ, and in fact in the embryos of the Insects and Crustacea. Figs. 172 and 173 represent the ringed larva. "A number of rings make their appearance at once, and are the more distinct the nearer they are placed to the mouth." The worm now greatly elongates, more segments are added and it appears as in Figs. 174 and 175, with the ciliated crown, the small short tentacles and eyes. The worm now swims about slowly and creeps over the bottom, and is nearly a quarter of an inch long. It will be observed that the larva differs from those of other Annelides, as Mr. Agassiz states, in the absence of "feet, bristles or appendages of any sort, except the two tentacles of the head; and, were it not for these, it would seem as if the young worm were the larva of some Nemertes-like animal." Fig. 176 represents the worm over four months after the stage represented by Fig. 175, the articulations have disappeared and a month later the head is separated from the body by a neck, the tentacles disappear, the body is flattened, and the Nemertes (Polia) form is attained.

It is thus interesting to know that the young Echinoderm (Fig. 96), the young mollusk (Fig. 140 B) and the young Nemertean worm pass through a similar free swimming Cephalula stage. We shall see farther on that the young Balanoglossus and the true Annelides pass through a similar phase. The changes through which the Nemertean worms pass are the following, though it should be borne in mind that different species pass through different cycles of growth, some exhibiting no metamorphosis, the stages being more or less condensed in the embryo state.

1. Egg.
2. Morula.
3. Planula (or Gastrula?) hatching as a
4. Ciliated Infusorian-like larva, or a
5. Pilidium or a Cephalula.

6. Nemertes (*a*) budding out from the Pilidium, or (*b*) arising by direct growth from the Cephalula.

LITERATURE.

Lovén. Jakttagelse ofver Metamorfos hos en Annelid. (K. Vet. Akad. Handlingar. Stockholm, 1840. Translated in Archiv fur Naturgeschichte. 1842, and Annales des Sc. Nat. 1842.)

Desor. Embryologie von Nemertes. (Muller's Archiv, 1848.)

Leuckart and Pagenstecker. Untersuchungen ueber niedere Seethiere. (Muller's Archiv, 1858.)

A. Agassiz. On the young stages of a few Annelides. (Annals Lyceum of Natural History. New York, 1866.)

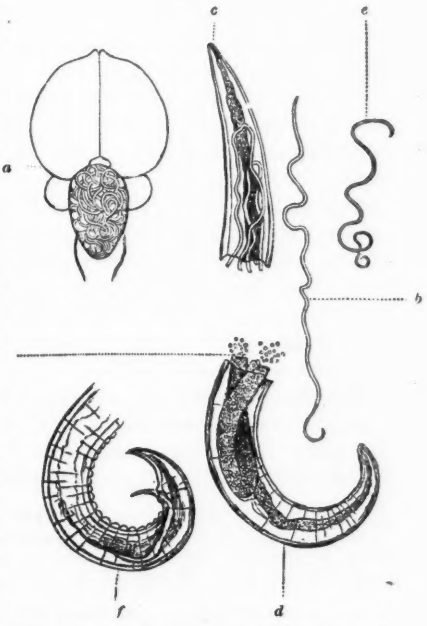
Metschnikoff. Entwickelung der Echinodermen und Nemertinen. (Mémoires Acad. Imp. Sciences. St. Petersbourg, 1869.)

Dieck. Beiträge zur Entwickelungsgeschichte der Nemertinen. (Jenaische Zeitschrift für Naturwissenschaft. 1874.)

II. NEMATELMINTHES (Round worms, Thread worms, Hair worms.)

There is little of interest in the development of the ordinary round worms, which whether free or parasitic are of the usual form, as shown in the Eustrongylus.

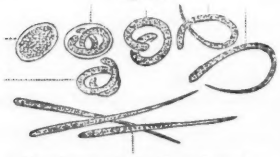
Fig. 177.



The mode of development of all these worms so far as known is very uniform. Development begins in three ways: (1) usually the egg undergoes total segmentation; others (2), as in *Ascaris dentata* and *Oxyuris ambigua*, do not show any trace of segmentation, and (3) in *Cucullanus elegans* there is no yolk, the nucleus absorbing all the vitelline matter which is limpid and transparent (E. Van Beneden). The germ consists of a single row of cells bent on itself somewhat as in Fig. 178, which represents a little more ad-

vanced state in Sagitta, and there are a few cells representing the entoderm. The Nematode may be said therefore to pass through an incomplete gastrula condition. The adult form is rapidly assumed in the egg. Fig. 178 after J. Wyman, represents the young of *Eustrongylus papillosus* in the egg and the worm just after hatching. Fig. 177, *a*, several mature worms coiled up in the brain of the snake bird; *b*, female; *c*, head much enlarged; *d*, end of the body; *e*, male; *f*, the end of its body, after Wyman.)

Fig. 178.



Development of a Round worm.

The *Trichina spiralis* is the author of the terrible disease called trichiniasis or trichinosis. The young worms exist in the flesh of the hog, where they become encysted, and if swallowed by man, the cysts are dissolved during digestion, and the young worms are set free in the intestinal canal. From here the young bore in all directions in the body, and becoming encysted cause the flesh to look as if sprinkled with white sand.

The development of the hair-worm (Gordius and Mermis) is quite complicated, as the young are parasitic, tadpole-shaped, living in the bodies of insects, especially grasshoppers, in whose bodies the mature worms are found coiled up. M. Villot is now publishing an account of the mode of development of these worms in a monograph appearing in Lacaze-Duthiers "Archives, but not yet completed. These worms are oviparous, laying exceedingly numerous, minute eggs agglutinated together, forming long white strings. The young of one genus live in the aquatic larvæ of flies and were afterwards found by Villot in the mucous layer of the intestines of fishes.

The diœcious round worms pass without metamorphosis through a morula, and a condensed gastrula state (not so well marked as in Sagitta) in the egg, assuming the adult form before hatching. In the hair worms there is a well marked metamorphosis.

LITERATURE.

Claparède. De la Formation et de la fécondation des Œufs chez les Vers Nématodes. Genève, 1859. Compare also papers by Bagge, Reichert, Siebold, Nelson, Schneider, Perez, E. Van Beneden and Villot.

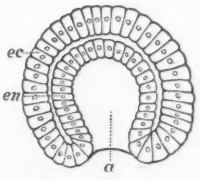
III. CHÆTOGNATHI (Sagitta).

This singular worm had been referred to the crustacea by some,

to the mollusca by Forbes, and even to the vertebrates by Meissner. Its development and structure, however, show that it is nearly related to the Nematodes. The mouth is, however, armed with six pairs of bristles; and a double-fin-like expansion of the sides and ends of the body gives it a slightly fish-like shape. This fin-like expansion is seen in the Cercaria, and the young ascidian, and is of little morphological importance. It swims on the surface of the water, not seeking the bottom or living parasitically.

Development of Sagitta. This animal is a hermaphrodite, and the eggs may be found in August well developed. Its development has been studied by Gegenbaur and Kowalevsky, by the latter in great detail. The egg undergoes total segmentation, a segmentation cavity being formed and the blastoderm invaginating exactly as in the Nematodes. This results in the formation of a gastrula-condition (Fig. 179) in which the infolding of the blastoderm leaves a well marked primitive body cavity. Soon at the opposite end of the body another cavity (the permanent mouth) forms, which deepens and connects with the primitive body cavity; this closes up at the posterior end, and the true digestive canal is formed. The embryo is oval, but soon elongates, and the adult Sagitta form is attained before the animal leaves the egg.

Fig. 179.



Gastrula of Sagitta.

The phases of development are then as follows:

1. Morula.
2. Gastrula (well marked, but not ciliated and free).
3. Adult Sagitta.

LITERATURE.

Gegenbaur. Ueber die Entwickelung der Sagitta. Halle, 1857.
Kowalevsky. Embryologische Studien an Würmen und Arthropoden. (Memoirs Acad. Imp. Sciences. St. Petersburg, 1871.)

IV. ACANTHOCEPHALI.

The Echinorhynchus (Fig. 180, head, after Owen); 181, the same, with the proboscis retracted (*a*, oral pore; *bb*, protractile muscles; *cc*, retractile muscles; from Owen), a singular worm,

without a mouth or alimentary canal, but with a large proboscis armed with hooks, evidently lives by imbibition of the fluids of its host. It is a not uncommon parasite of fishes. Fig. 182 represents an allied(?) form (*Koleops anguilla*) described by Dr. Lockwood, who found it in the eel (AMERICAN NATURALIST, vi, 1872).

Fig. 182.

Koleops.

Development of Echinorhynchus gigas. Schneider has given the only account we have of the early stages of this worm. "The ova of this worm are scattered upon the ground by the pigs. Here they are eaten by the larvæ of *Melolontha vulgaris* [a beetle allied to our June beetle], and thus arrive at their further development. The ova burst in the stomach of the larva, and the embryos contained

Fig. 180.

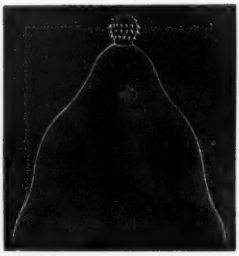
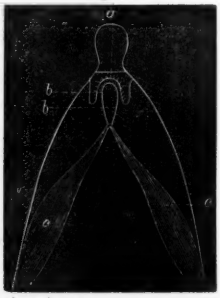


Fig. 181.



Head of Echinorhynchus.

in them can then penetrate, by means of their spines, through the intestine into the body cavity of the larva; here they become developed, and again reach the intestine of the pig by the agency of the larva.

"The larvæ infested with Echinorhynchi live on until their metamorphosis into cockchafers. . . . . When the embryos have arrived at the body cavity of the larvæ of Melolontha, they remain for some days unaltered and capable of motion; they then become rigid, acquire an oval form, and envelope themselves in a finely cellular cyst, which is formed of the connective tissue of the larva. The skin of the embryo, with its circlet of spines at the anterior extremity, continues at first to be the skin of the growing larva; and it is only at a later period, when the forma-

tion of the hooks commences, that it is thrown off, when it forms a second cystic envelope. The embryo, or rather the larva, proceeding from it, divides very soon into two layers, a thick dermal layer and an inner cell-mass, from which the other organs originate." The ovaries and testes are produced at a very early stage.

LITERATURE.

Schneider. On the development of *Echinorhynchus gigas.* (Sitzungsbericht der Oberhessischen Gesellschaft für Natur und Heilkunde, 1871. Translated in Annals and Mag. Nat. Hist., 1871.)

V. ROTATORIA.

The Rotifers, by some eminent naturalists regarded as crustacea, are shelled worms, related to the flat-worms in many respects. The body consists of several segments, and the sexes are very unlike, the small males having the organs more or less rudimental, with no alimentary canal. Like the lower worms they have a set of tubes excretory in their nature and perhaps respiratory, corresponding to the water vascular tubes of the Radiates, but with fine ciliated infundibuliform orifices comparable with the segmental organs of the Brachiopods and higher worms; also a pair of teeth in the pharynx, as in many worms. The anus is situated on the back at the base of the tail. Sometimes the digestive canal ends in a blind sac. The distinctive organ is the retractile, ciliated, paired organ which may be called the velum. Fig. 183[1] from H. J. Clark, represents *Squa-*

Fig. 183.

A Rotifer.

[1] *Squamella oblonga*, magnified 200 diameters. From fresh water. A view from below; shell or carapace (s, s^1, s^2); s, the anterior transverse edge of the carapace; s^1, the anterior, and s^2, the posterior corners of the carapace; s^3, the border of the oval, flat area which occupies the lower face of the carapace; *lb*, the cilia-bearing velum of the head; t, the fork of the tail (t^1); m, the mouth; j, jaws; j^1, muscles which move j; *st*, stomach; *cv*, the contractile vesicle, or heart of the aquiferous circulatory system; cv^1, cv^2, the right, and cv^3, cv^4, the left aquiferous circulatory vessels; eg, eg^1, eg^2, two largely developed young.—Clark's "Mind in Nature."

mella oblonga of Ehrenberg, found in this country. It is closely allied to Brachionus.

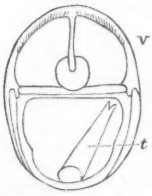
Development of the Rotifers. The sexes are distinct. The females lay both summer and winter eggs, the former being unfertilized, like the summer eggs of the Cladocera (Daphnia). The Rotifers live in damp places in water and revive after being nearly dried up for a long time. Dr. Salensky has been the first to give a complete sketch of the life-history of a Rotifer, *Brachionus urceolaris*.

The eggs of Brachionus are attached by a stalk to the hinder part of the body of the female. The following remarks apply to the female eggs, which are quite distinguishable from the masculine ones. The eggs undergo total segmentation, and the outer layer of cells resulting from subdivision form the blastoderm, when the formation of the organs begins. The first occurrence is an infolding of the blastoderm (ectoderm) forming the primitive mouth, which remains permanently open, the mouth not opening at the opposite end as in Sagitta, but the entire development of the germ is as in Calyptræa, as Salensky often compares the earliest phases of development of the Rotifer with those of that mollusk. The "trochal disk," or velum, as we may call the ciliated disk of the Brachionus, arises as in certain mollusks, as a swelling on each side of the primitive infolding. Behind the primitive hole appears another swelling, which becomes the "foot" or tail.

There is soon formed at the bottom of the primitive infolding a new hole or infolding, which is the true mouth and pharynx, while a swelling just behind the mouth becomes the under lip.

Soon after, the two wings of the velum become well marked, and their relation to the head is as constant as in Calyptræa. The foot becomes conical, larger, and the termination of the intestine and anal opening is formed at the base.

Fig. 184.



Brachionus nearly ready to hatch.

The internal organs are then elaborated; first the nervous system, consisting of but a single pair of ganglia arising from the outer germ-layer (ectoderm). Soon after the sensitive hairs arise on the wings of the velum.

Fig. 184 shows the advanced embryo, with the body divided into segments, the pair of ciliated wings of the velum (v), and the long tail (t). At this time the

shell begins to form, and afterwards covers the whole trunk, but not the head.

The inner organs are developed from the inner germ-layer (endoderm), which divides into three leaves, one forming the middle part of the intestine, and the two others the glands and ovaries. The pharyngeal jaws arise as two small projections on the sides of the primitive cavity.

The male develops in the same mode as the female. The Rotifers, so far as can be judged from one species, seem to develop in a manner quite unlike other worms, and in the earliest phases much as in some Gastropods, the mode of their embryology not throwing much light on the affinities of the group, which is of doubtful position, though with more of the characters of worms than crustacea.

The young pass through a morula state, and the embryo directly attains the mature form in the egg.

LITERATURE.

Salensky. Beitrage zur Entwicklungsgeschichte der *Brachionus urceolaris.* (Siebold and Kölliker's Zeitschrift, 1872). Compare also the papers of Huxley, Leydig, Cohn, Gosse and Nägeli.

REVIEWS AND BOOK NOTICES.

SULLIVANT'S ICONES MUSCORUM, OR FIGURES AND DESCRIPTIONS OF MOST OF THOSE MOSSES PECULIAR TO NORTH AMERICA, WHICH HAVE NOT YET BEEN FIGURED. — *Supplement* (*Posthumous*). With eighty-one copper plates, imp. 8vo. Prefaced by a Biographical Sketch of the author, by ASA GRAY. Mr. Sullivant died on the 30th of April, 1873, leaving the plates of this exquisite volume ready for publication, and the letter-press partially so. The latter has been completed by his friend and associate, Mr. Lesquereux; and the volume has at length been brought out, at the expense of Mr. Sullivant's executors, and in accordance with his wishes. Only a very small edition has been printed. The delicate copper plates were not intended for a large impression; and the number of botanists interested in the serious study of mosses is supposed to be small.

As with the larger first volume, with one hundred and twenty-three plates, issued ten years ago, so with this supplementary one now bequeathed to botanists, the sale of the whole edition, at the price for the present fixed, would be far from covering the actual

pecuniary outlay in the production. The work is a gift to bryological science by one of its most distinguished cultivators, who, fortunately, was blessed with the means which enabled him to bestow it. He accordingly fixed a price much below the cost, so as to bring the work fairly within the reach of students who may desire it. This policy will still be adhered to for a sufficient time to enable those in this country who need the work to obtain it advantageously. For the present the price of the original volume will be $14.00; of the supplement $10.00; of the two together, $24.00. It is supplied by the American Naturalists' Agency, as well as by Charles W. Sever, Cambridge, Mass., by Westermann & Co., New York, and by Trubner & Co., London. — Asa Gray.

BOTANY.

Introduction of Ulex europæus in the Bermudas. — In the winter of 1872–3, I sowed English seed of this shrub in my garden, and a few healthy plants were produced in the course of twelve weeks or so. Leaving for the north for the summer months, I thought it best, to insure their safety, to present them to His Excellency the Governor, Major General Lefroy, whose endeavors to introduce new forms of vegetation into the islands are widely known and appreciated. The plants died during the summer. More seeds were then sown in Government House garden and came up well, and being transplanted into favorable positions, throve beyond expectation, and in February last I had the pleasure of seeing several plants, arranged as a thicket on a northwestern slope, in blossom. Still, I was somewhat skeptical regarding the ultimate result, knowing that this form refuses to grow farther south than the latitude of 42° in the eastern hemisphere, but much to my satisfaction the legumes duly formed, and the seeds became fully ripe at the beginning of this month, so that the plant may now be said to be naturalized in these islands. — J. Matthew Jones, *the Hermitage, Bermudas, May* 12, 1875.

ZOOLOGY.

Mr. Gentry's paper on Fertilization through Insect Agency. — It is to be regretted that this interesting paper fails just where it might be of scientific value. If Mr. Gentry, who, by the context of the article evidently anticipated cross fertilization, had enclosed a few female flowers in gauze bags, and self

fertilized them, the case of *Cucurbita ovifera* would have been complete, and in Wistaria how easy to take pollen from some mature flowers and impregnate the younger ones. It is tantalizing to be put off with "incontrovertible" inferences and suggestions, when the material for actual proof was so near at hand.—T. MEEHAN.

COLORADO POTATO BEETLE DESTROYED BY THE ROSE-BREASTED GROSBEAK.—I noticed last summer that great numbers of the Colorado potato beetle were destroyed by the Rose-breasted grosbeak, *Goniaphea Ludoviciana*.

The farmers hold these birds in great favor, and are very careful to prevent their destruction. They were so abundant in this region last summer as to hold in check the vast army of these ravagers of the potato crop.—W. F. BUNDY, *Jefferson, Wis., Feb.* 25, 1875.

THE UMBELLULA.—A monograph of the genus has just been received from Mr. Lindahl, published in the Swedish Transactions. These polypes are sea pens, with a remarkably long stalk, attaining the length of two or three feet. The species are of great rarity, occurring at great depths off Spitzsbergen, Baffin's Bay, North Greenland, and off Cape Finisterre. A second genus, Crinillum, occurred in Banka Sea.

CIGARS DESTROYED BY INSECTS.—The disciples of Mr. Trask will be glad to know that "the weed" is devoured by three kinds of insects, and thus rendered unfit for the use of man. In a collection found by a friend in a lot of cigars, which they had ruined, Dr. Horn enumerates three beetles: *Catorama simplex*, *Xyloteres?* and *Calandra oryzæ*.

GEOLOGY AND PALEONTOLOGY.

THE SAND DUNES OF THE SAN LUIS VALLEY.—On our homeward march while in the service of the U. S. Geological Survey (Dr. F. V. Hayden's) during the summer of 1874, we passed close to the well-known "sandhills" of the San Luis Valley lying at the base of the Sangre de Christo Range opposite Musca Pass. They consist of a range of angular dunes extending in horse-shoe form for some ten miles, the central points of which will average over seven hundred feet in height, making a very prominent object

against the dark back-ground afforded by the Sierras Sangre de Christo and Belanca. Outside of this range of sandhills along their whole extent stretches a perfect *arena* (literally), into the eastern end of which a river of considerable size rushes down, and is utterly lost in five hundred yards, reappearing again, much diminished, several miles below. This floor of sand and the square sides of the dunes to the very top has been ruffled by the wind into small irregular furrows identically the same as the ripple-marks made by the water on a sandy beach. But while the body of this pure fine sand is hammered as compact as that under the waves, the surface is a little softer, so as to readily receive and preserve in ordinarily still weather such delicate marks as the tracks of spiders and small lizards. I noticed also that portions of this ripple-marked floor which had not been recently disturbed, was of a slightly different color from newly exposed sand. It struck me at the time, that sand might easily be blown over this smooth surface without disturbing it, and should it lie there long enough to become rock, this first surface would form a natural line of separation between the strata, having every appearance of an old ripple-marked beach perhaps containing impressions and delicate fossils, when in fact no water had been near it, and the wind alone was accountable for the whole.—Ernest Ingersoll.

MICROSCOPY.

Double Staining of wood and other Vegetable Sections. —I have lately discovered that benzole fixes the anilines when they are used in staining vegetable and animal tissues. It not only instantly fixes any aniline color in vegetable tissues, but also renders them as transparent as oil of cloves.

Finding that benzole possessed this property, led me to try double staining upon sections of leaves and sections of wood. The results have proved highly satisfactory. I have found the following processes successful:—A section, say of wood, being prepared for dyeing, is put for five or ten minutes in an alcoholic solution of "Roseine Pure" (Magenta), one-eighth or one-quarter of a grain to the ounce. From this it is removed to a solution of "Nicholson's Soluble Blue Pure," one half-grain to the ounce of alcohol, acidulated with one drop of nitric acid. In this it should

be kept for thirty or ninety *seconds*, rarely longer. It should be frequently removed with the forceps during this period, and held to the light for examination, so that the moment for final removal and putting into benzole be not missed. After a little practice the eye will accurately determine the time for removal.

Before placing the object in benzole it is well to hold it in the forceps for a few seconds, letting the end touch some clean surface, that the dye may drip off, and the object may become partially dry. By doing this, fewer particles of insoluble dye rise to the surface of the benzole, in which the brushing is done to remove foreign matter. The object should then be put into clean benzole. In this it may be examined under the glass. If it is found that it has been kept in the blue too short a time, it should be thoroughly dried, and, after dipping in alcohol, be returned to that dye. If a section of leaf or other soft tissue be under treatment, it should be put in turpentine or oil of *juniper*, as they do not contract so much as benzole.

When hæmatoxylon is used instead of magenta, it is followed by the blue as just described. As neither of these dyes comes out in alcohol or in oil of cloves, the section may be kept in the former for a short time before placing in the latter.

The hæmatoxylon dye I prefer is prepared by triturating in a mortar for about ten minutes two drachms of ground Campeachy wood with one ounce of absolute alcohol, setting it aside for twelve hours, well covered, triturating again and filtering. Ten drops of this are added to forty drops of a solution of alum; twenty grains to the ounce of water. After one hour the mixture is filtered.

Into this the section, previously soaked in alum-water, is placed for two or three hours, or until dyed of a moderately dark shade. When dyed of the depth of shade desired, which is determined by dipping it in alum-water, the section is successively washed for a few minutes each, in alum-water, pure water and fifty per cent. alcohol. Finally it is put in pure alcohol until transferred to the blue.

Carmine and aniline blue produce marked stainings, but they are rather glaring to the eye under the glass. I use an ammoniacal solution of the former, double the strength of Beale's, substituting water for glycerine. In this a section is kept for several hours. On removal it should be dipped in water, and then put for a few

minutes in alcohol acidulated with two per cent. of nitric acid; then in pure alcohol; then in the half-grain blue solution before spoken of, from which it should be removed to alcohol; then to oil of cloves. Much color will be lost in the acid alcohol. The acid is to neutralize the ammonia, which is inimical to aniline blue. Magenta aniline or hæmatoxylon may be used with green instead of blue aniline. The brand of green I prefer is the iodine brand, one grain to the ounce of alcohol.

Double stainings of sections of leaves in which red is first used, have the spiral vessels stained this color, other parts being purple or blue. Radial and tangenital sections of wood have the longitudinal woody fibres red, and other parts purple or blue.

This selection of color is, I think, due to the fact that spiral vessels and woody fibres take up more red than other parts, and are slower in parting with it. The blue, therefore, seems first to overcome the red in parts where there is less of it. It will entirely overcome the red if sufficient time be given.

If the blue be used before the magenta aniline, the selection of color is reversed.

I would here call special attention to the importance of examining these stainings at night, as the red in them has a trace of blue in it which does not show at that time, but comes out so decidedly by daylight, as to change, even spoil, the appearance of the specimen.

I think they should be mounted in Canada balsam, softened with benzole, as the presence of the latter may be beneficial in preserving its magnets.

I would offer a few words upon section-cutting, and upon preparing sections for dyeing.

To cut a thick leaf, place a bit of it between two pieces of potato or turnip, and tie with a string. Cuts may be made along the midrib, or across it, including a portion of leaf on either side, or through several veins. Fine shavings of wood may be used, or pieces rubbed down on hones.

Sections of leaves may be decolored for staining by placing for some time in alcohol; but I would recommend the use of Labarraque's solution of chlorinated soda, for a few hours after the alcohol. Especially do I recommend the Labarraque for all kinds of wood. In twelve hours wood is generally bleached; too long a residence in it will, however, often cause it to fall in pieces.

After removing from the soda, wash through a period of twelve or eighteen hours in half a dozen waters, the third of which may be acidulated with about ten drops of nitric acid to the ounce, which acid must be washed out. Next put in alcohol, in which sections and also leaves may be kept indefinitely, ready for dyeing.

Magenta, when used for leaves, should be of the strength of one-eighth or one-quarter of a grain to the ounce of alcohol, and purples and iodine-green two or three times as strong. These anilines are inferior to the blue in bringing out all the anatomical parts of a leaf, including the beautiful crystals so often met with. On removal from the dye, leaves should be thoroughly brushed with camel-hair pencils.

One week, instead of forty-eight hours, is frequently required to effect the decoloration of large leaves in chlorinated soda, even when they are cut into several pieces, which is advisable.

Mr. L. R. Peet, of this city, whose stainings in aniline are unsurpassed for beauty, thinks better results are attained by commencing with a weak dye, say from one-twentieth to one-twelfth of a grain, and slowly increasing the strength of the dye, at intervals of from one to three hours, until the required hue is obtained. This process certainly guards against too deep staining, and may give a finer tone to leaves under the glass.—Geo. D. Beatty, M.D., *Baltimore, in Science-Gossip.*

NOTES.

American Association for the Advancement of Science.—The 24th meeting of the Association will be held in Detroit, Mich., beginning on *Wednesday, August* 11, next. The circular of the Permanent Secretary states that the headquarters of the Association will be at the Russell House, on Monday and Tuesday preceding the meeting, and on Wednesday and the following days at the City Hall and Court House, where the general and sectional sessions will be held, and where the Association will be well accommodated. The citizens of Detroit have formed a large working local committee, comprising nearly two hundred of the leading citizens, with the Governor of the State as Chairman, and we are assured that everything possible will be done to make the meeting a successful one so far as the local arrangements are concerned, while the extraordinary interest taken in the last meeting by the members indicates that the scientific element of the next meeting will be

well sustained. The election of all the important officers a year in advance will not only save much time in organizing the Detroit meeting but will also secure special addresses from the presiding officers of the sections, similar to those which make so important a part of the proceedings of the British Association.

At an early date the Local Committee will issue their circular to members of the Association, giving details relating to the arrangements made for the accommodation of members while in Detroit, and such other information as may be of interest to those intending to be present at the meeting, including any facilities offered by the railroads, reduction of hotel prices, contemplated excursions, etc. In order to receive the circular of the Local Committee without fail, it is desired that all persons now planning to attend the meeting should send their addresses to Frederick Woolfenden, Esq., Secretary of the Local Committee, Detroit.

Professor F. W. Clarke of Cincinnati, appointed by the Chemical Subsection of the Hartford Meeting to notify chemists of the organization of a *Permanent Subsection of Chemistry*, requests that attention be called to the fact that the subsection is a permanent organization, and states that the general interest awakened among the chemists indicates a large gathering at Detroit of those specially interested in that department.

The attention of persons specially interested in Entomology is directed to the action taken by the Entomologists at the Hartford meeting, and to the fact that there will be a meeting of the Entomological Club of the Association at Detroit, on Tuesday, August 10 (the day preceding the meeting of the Association), at which all interested are invited to be present.

It was also suggested at the last meeting that special efforts be made to bring the Ethnologists and Archæologists together at Detroit in order to form a permanent subsection of Anthropology, and it is probable that definite action will be taken on the subject at the coming meeting.

Any person may become a member of the Association upon recommendation in writing by two members or fellows, nomination by the Standing Committee, and election by a majority of the members and fellows present in general session. Blank forms for recommendation to membership, and also copies of the general circular, will be furnished on application to F. W. Putnam, Permanent Secretary, Salem, Mass.

The following are the Officers of the Detroit Meeting:—President, J. E. Hilgard, of Washington; Vice-President, Section A, H. A. Newton, of New Haven; Vice-President, Section B, J. W. Dawson, of Montreal; Chairman of Chemical Subsection, S. W. Johnson, of New Haven; Permanent Secretary, F. W. Putnam, of Salem; General Secretary, S. H. Scudder, of Cambridge; Secretary of Section A, S. P. Langley, of Alleghany, Pa.; Secretary of Section B, N. S. Shaler, of Newport, Ky.; Treasurer, W. S. Vaux, of Philadelphia.

Standing Committee:—Past Presidents, Wm. B. Rogers, of Boston; Joseph Henry, of Washington; Benjamin Peirce, of Cambridge; James D. Dana, of New Haven; James Hall, of Albany; Alexis Caswell, of Providence; Stephen Alexander, of Princeton; Isaac Lea, of Philadelphia; F. A. P. Barnard, of New York; J. S. Newberry, of New York; B. A. Gould, of Boston; T. Sterry Hunt, of Boston; Asa Gray, of Cambridge; J. Lawrence Smith, of Louisville; Joseph Lovering, of Cambridge; the President, Vice-Presidents, Secretaries, and Treasurer of the Detroit Meeting. As Officers of the Hartford Meeting, John L. LeConte, of Philadelphia; C. S. Lyman, of New Haven; A. C. Hamlin, of Bangor; from the Association at large, Six Fellows to be elected on the first day of the meeting.

Local Committee:—Chairman, His Excellency, Governor John J. Bagley; Treasurer, William A. Butler, Esq.; Secretary, Frederick Woolfenden, Esq.; also special sub-committees on Reception, Rooms, Excursions, Entertainment, Printing, etc.

Bulletin No 2, second series of Hayden's geological and geographical Survey of the Territories was issued May 14th by the Department of the Interior. It contains important papers as follows:—I, Monograph of the genus Leucosticte, Swainson; or, Gray-crowned Purple Finches, by Robert Ridgway. II, The cranial and dental characters of Geomydæ, by Dr. Elliott Coues. III, Relations of Insectivorous Mammals, by Theodore Gill. IV, Report on the Natural History of the United States Geological and Geographical Survey of the Territories, 1874, by Ernest Ingersoll.

This was followed on the next day by a third Bulletin, being a "Topographical and Geological Report on the San Juan Country" by A. D. Wilson, the topography illustrated by a map; with a

second topographical report, and a most entertaining narrative it is, by Franklin Rhoda, assistant topographer. This is illustrated by characteristic panoramic views of Mt. Sneffles and adjoining mountains, and of the quartzite peaks seen in looking across the great cañon of the Animas. These reports and two heliotypes of the eroded rocks of Colorado, with an explanatory note by Prof. Hayden, the Geologist in charge, render this a most timely issue, of value to miners.

As a result of the institution of the Anderson School of Natural History at Penikese Island, we are gratified to see the establishment of a similar school in Normal, Illinois.

Arrangements have been completed for a summer meeting of the association of Natural History of Illinois, for the study of botany and zoology, to be held at the museum at Normal, Illinois, commencing July 14th, and continuing until August 11th.

The following gentleman have been engaged as instructors for the term: — Prof. B. G. Wilder, Prof. W. S. Barnard, Ph.D., Prof. T. J. Burrill, Prof. Comstock, and Prof. S. A. Forbes.

It is found necessary to limit the attendance to fifty students; but, within this limit, the class will be open to the teachers of the State. It is desirable that all names should be sent to the committee by the fifteenth of June.

A part of the expenses of the session will be defrayed by a tuition fee of ten dollars for each student; the remainder have already been provided for through the generosity of friends.

The school is to be conducted by the executive committee of the association. We hope to see similar schools forming next year, at least one for each section of the country.

The Zoological Garden at Philadelphia is rapidly increasing its collection of American and exotic animals. Mr. Goode has recently brought from Florida, according to "The Rod and the Gun," one hundred and thirty-two specimens representing thirty-two species, distributed as follows: mammals, five species; birds, one; lizards, four; serpents, sixteen; turtles, five; amphibians, one. A number of Florida wild hogs have been engaged and negotiations are in progress for some manatees from the Indian River country.

Lt. Wheeler's Progress Report upon geographical and geological explorations and surveys west of the one hundredth meridian

in 1872 has been lately issued. It is a quarto pamphlet of fifty-six pages, and is illustrated with four excellent heliotypes of the striking scenery of the cañon of the Colorado, and with maps, including a progress map of explorations and surveys conducted by the War Department. Appended are reports of the other officers and civilians connected with the survey. We shall look with interest for the appearance of the final report of the survey.

Dr. Gill's "Catalogue of the Fishes of the East Coast of North America" which originally appeared as an Appendix to Prof. Baird's Report on the Fish and Fisheries of the United States, has been republished by the Smithsonian Institution.

The importation into Finland or any portion of Russian territory of American potatoes, or sacks, cases, or any other articles, which have contained them is prohibited. We suppose on account of the fear of introducing the Colorado potato beetle.

The "San Diego Lyceum of Natural Sciences" was organized at San Diego Cal., in 1873. The officers for 1875 are Dr. R. J. Gregg, *President*, and George N. Hitchcock, *Secretary*.

"The Vineland Natural History Club," with about twenty-five members, was organized at Vineland, N. J., March 25, under the Presidency of Mr. D. F. Morrill.

The "Nebraska Association for the Advancement of Science" has been established at North Platte, Nebraska. I. W. LaMunyon is President, and A. H. Church, Secretary.

Dr. John Edward Gray, late keeper of the zoological department of the British Museum, died March 21st, at London, aged 75. He was the leading editor of the "Annals and Magazine of Natural History."

Prof. Marsh has secured for the museum of Yale College, a perfect skeleton of the mastodon lately exhumed at Otisville, Orange Co., N. Y.

Prof. F. V. Hayden has been elected a corresponding member of the Geological Society of London.

Prof. Cyrus Thomas has been appointed State Entomologist Illinois.

The Anderson School at Penikese has been discontinued for the present season, for want of funds.

THE library of Audubon was destroyed by fire April 29th at Shelbyville, Ky. It was in the house of Mrs. Lucy Bakewell, in the sister-in-law of Mr. Audubon. The collection consisted of about eight hundred volumes.

BOOKS RECEIVED.

Twenty-first Annual Report and Abstract of Proceedings of the Brighton and Sussex Natural History Society. Brighton, 1874. pp. 122. 8vo.

Estrada de Ferro do Recife as S. Francisco, Estudos Definitivos de una a Boa-Vista, Executados sob a direccao de J. M. da Silva Coutinho. Rio de Janeiro, 1874. pp. 155. 4to.

Botanical Contributions. By Asa Gray. *Conspectus of the North American Hydrophyllaceæ.* Ex. from Proc. Am. Acad. Arts and Sciences, 1875. pp. 312-332 8vo.

Contributions to American Botany, V. Revision of the Genus Ceanothus, and Descriptions of New Plants with a Synopsis of the Western Species of Silene. By Sereno Watson. From Proc. Am. Acad. Arts and Sciences. pp. 329-350. 8vo.

Geographical Explorations and Surveys West of the One Hundredth Meridian. Engineer Department, U. S. Army. Systematic Catalogue of Vertebrata of the Eocene of New Mexico, Collected in 1874. Washington, 1875. pp. 37. 8vo.

U. S. Commission of Fish and Fisheries. Commissioner's Report, 1872-73. Washington, 1874. pp. 910. 8vo.

Quarterly Journal of Microscopical Science. London, 1875. No. LVIII. pp. 209. 8vo.

Verhandlungen des Naturforschenden Vereines. Brunn, 1874. xii Band, 1, 2, Heft. 8vo.

Jenaische Zeitschrift fur Naturwissenschaft. Jena, 1875. ix, Bd. N. F. ii, Bd. i. pp. 132. 8vo.

Proceedings of the Royal Society of Edinburgh. 1873-74, vol. viii, No. 87. pp. 207-414. 8vo.

Archiv fur Anthropologie. Zeitschrift fur Naturgeschichte und Urgeschichte des Menschen. Braunschweig, 1875. Band 7, Nos. 3, 4. pp. 473. 4to.

Catalogue of Lower Silurian Fossils, with Descriptions of some New Species. By U. P. James. Cincinnati, 1875. pp. 8. 8vo.

The Canadian Antiquarian and Numismatic Journal. Montreal, 1875. Vol. 3, No. 4. pp. 145-192. 8vo.

The Influence of Anæsthetics on the Vaso-Motor Centres. By Henry P. Bowditch and Charles Sedgwick Minot. Boston, 1874. pp. 8. 8vo.

Notes on Some of the Phenomena of the Glacial Era and their Origin; in Book Notices. By James D. Dana. pp. 311-317. 8vo.

Memoirs of the Boston Society of Natural History. Vol. II, Part iv, No. 1. *Prodrome of a Monograph of the Tabanidæ of the United States.* Part 1. *The Genera Pangonia, Chrysops, Silvius, Hæmatopota, Diabasis.* By C. R. Osten Sacken. Boston, 1875. pp. 365-397. 4to.

The Oologist. Vol. 1, No. 3. May, 1875, Utica. pp. 17-24. 8vo.

Bulletin de la Societe Geologique de France. 3e Serie, t. III. Paris, 1875, No. 3. 8vo.

Curious Anomaly in History of Certain Larvæ of Acronycta oblinitus, Guenee, and Hints on Phylogeny of Lepidoptera. By Thomas G. Gentry. Proc. Acad. Nat. Sci., Phil. 1875. pp. 24-54. 8vo.

List of the Marine Algæ of the United States, with Notes of New and Imperfectly Known Species. By W. G. Farlow Proc. Am. Acad. Arts and Sciences, 1875. pp. 351-380. 8vo.

First Annual Report of the Geological and Agricultural Survey of Texas. By S. B. Buckley. Houstan, 1874. pp. 142. 8vo.

The Recent Origin of Man. By James C. Southall. Philadelphia, Lippincott & Co., 1875. pp. 606. 8vo.

Monograph of the Genus Leucosticte, Swainson; or, Gray-Crowned Finches. By Robert Ridgway. Washington, 1875. pp. 51-82. 8vo.

On Dr. Koch's Evidence with regard to the Cotemporaneity of Man and the Mastodon in Missouri. By James D. Dana. From Am. Journ. Science and Arts. Vol. ix, May, 1875. pp. 335-346. 8vo.

The Diagonal System in the Physical Features of Michigan. By A. Winchell. Am. Journ. Science and Arts, Vol. vi. July, 1873. 8vo.

The Climate of Michigan. By Alexander Winchell. 8vo.

The Isothermals of the Lake Region in North America. By Alexander Winchell. From Proc. Am. Asso. Adv. Science, 1870. pp. 3-13. 8vo.

Syracuse University, Annual Report to the Board of Trustees. By Alexander Winchell, 1874. pp. 17. 8vo.

Michigan. Being Condensed Popular Sketches of the Topography, Climate and Geology of the State. With Charts. By Alexander Winchell, 1873. pp. 121. 8vo.

Religious Ideas Among Barbarous Tribes. 1. Facts. By Alexander Winchell. From Methodist Quarterly Review. Jan., 1875. pp. 5-27. 8vo.

The Unity of the Physical World. II. Facts of Succession. By Alexander Winchell. From Methodist Quarterly Review, Jan., 1874. 8vo.

Revue Scientifique de la France et de l'Etranger. No. 44, 1er mai, 1875. Quartrieme annee, 2e Serie.

Descriptions of Two New Species of Birds of the Families Tanagridæ and Tyrannidæ. By Geo. N. Lawrence. Annals Lyceum Nat. Hist., N. Y., Vol. xi, 1874. pp. 70-72. 8vo.

Descriptions of Four New Species of Birds from Costa Rica. By Geo. N. Lawrence. Annals Lyceum Nat. Hist., N. Y., Vol. xi, 1875. pp. 88-91. 8vo.

The Entomologist's Monthly Magazine. Vol. xi, London, May, 1875. 8vo.

Report of Progress of the Mineralogical, Geological and Physical Survey of the State of Georgia. For the period from Sept. 1, to Dec. 31, 1874. pp. 36. 8vo.

Bulletin of the U. S. Geological and Geographical Survey of the Territories. F. V. Hayden in charge. Second Series, Bulletin, No. 2, 3, 1875. 8vo.